NATURE-BASED TOURISM OPERATOR RESPONSE TO

ENVIRONMENTAL CHANGE IN JUNEAU, ALASKA

By

Kristin Timm

RECOMMENDED:

Dr. Erin C. Pettit

Dr. Karen M. Taylor

Dr. Sarah F. Trainor

Dr. Elena B. Sparrow
Advisory Committee Chair

Dr. Peter Fix
Department Chair, Natural Resources Management

APPROVED:

Dr. Stephen D. Sparrow
Dean, School of Natural Resources and Extension

Dr. John C. Eichelberger
Dean of the Graduate School

8/15/14
Date

NATURE-BASED TOURISM OPERATOR RESPONSE TO ENVIRONMENTAL CHANGE IN JUNEAU, ALASKA

A

THESIS

Presented to the Faculty

of the University of Alaska Fairbanks

in Partial Fulfillment of the Requirements

for the Degree of

MASTER OF SCIENCE

By

Kristin Timm, B.A.

Fairbanks, AK

August 2014

ABSTRACT

Increasing temperatures are projected to have a positive effect on the length of Alaska's summer tourism season, but the natural attractions that tourism relies on, such as glaciers, wildlife, fish, or other natural resources, may change. In order to continue to derive benefits from these resources, nature-based tour operators may have to adapt to these changes, and communication is an essential component of the adaptation process. The goal of this study is to determine how to provide useful climate change information to nature-based tour operators by answering the following questions: 1. What environmental changes do nature-based tour operators perceive? 2. How are nature-based tour operators responding to climate and environmental change? 3. What climate change information do nature-based tour operators need? To answer these questions, 24 nature-based tour operators representing 20 different small and medium sized businesses in Juneau, Alaska were interviewed. The results show that Juneau's nature-based tour operators are observing, responding to, and in some cases, actively preparing for changes in the environment. The types of environmental changes observed depended on the types of resources operators relied on and the way they accessed those resources, but a majority of the operators revealed that the loss of glaciers is a particularly large risk to their businesses and the tourism industry as a whole. Despite the observation of or perception of future risks, nearly a third of nature-based tour operators are not responding to changes in the environment. The remainder of nature-based tour operators were coping with environmental change, by changing their tour activities, expanding existing risk management activities, or participating more generally in conservation activities like recycling and fuel reduction. Only a few of the nature-based tour operators were planning for climate change, and taking strategic approaches to adaptation like including climate change

in their business plans or creating a company task force. Using data about certainty in climate change information and the perceived risks to the organization, this study proposes a framework to classify climate change responses for the purpose of generating meaningful information and communication processes that promote adaptation or build adaptive capacity in the tourism sector. The results of this study demonstrate that science communication research has an important place in climate change adaptation and sustainability science.

TABLE OF CONTENTS

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

LIST OF FIGURES

Page

List of Figures (Continued)

LIST OF TABLES

Page

LIST OF APPENDICES

Page

ACKNOWLEDGEMENTS

There are many people and organizations that helped to make this degree and research possible. First, I would like to acknowledge my committee members—Elena Sparrow, Karen Taylor, Erin Pettit, and Sarah Trainor—for being encouraging, supportive mentors throughout this process. Both academically and personally, you are some of the most inspiring women I know. I am so fortunate to have had this opportunity to work with and learn from you all. I would also like to acknowledge several other faculty who have given me incredible opportunities and have helped me learn, grow, and better understand the research process and this social-ecological system: Todd Brinkman, Cathy Connor, Eran Hood, Jeff Kavanaugh, Nathan Kettle, Shad O'Neel, Sanjay Pyare, Allison Bidlack, and Scott Rupp. I'd also like to acknowledge Jim Powell, who I collaborated with on this project, for his help in conducting some of the interviews. and providing valuable feedback on the development of the questionnaire. Our research was performed under the approval of the University of Alaska Fairbanks Institutional Review Board (423231-3).

I wouldn't have been able to conduct this research without the support of Alaska EPSCoR who funded my research activities. I am also appreciative of all the organizations that have enabled me to have teaching and research assistantships and attend some conferences throughout my graduate studies, including the NSF ARCSS Thermokarst Project, the UAF Resilience and Adaptation Program (RAP), the Alaska Climate Science Center (AK CSC), and the Scenarios Network for Alaska and Arctic Planning (SNAP), and the Alaska Center for Climate Assessment and Policy (ACCAP).

I'm grateful for the opportunity to have participated in the UAF Resilience and Adaptation Program, and I would like to thank the other students and faculty who have provided an amazing and necessary support system on this interdisciplinary research road. I am also thankful for my RAP internship and time with the Juneau Icefield Research Program (JIRP) where I was able to better develop my understanding of the physical system in which I was working.

Last but not least, I couldn't have done this without the generous love and support from my husband Jake Timm, my family, and friends. You all know who you are, and your encouragement will never be forgotten! Thank you.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Tourism accounts for about 21% of jobs and 14% of earned wages in Southeast Alaska and is the second largest economic activity in the region (McDowell Group, 2014). In Alaska, tourism relies heavily on ecosystem services—or those benefits derived from the natural environment—but some of these services and associated resources are changing. Between 1949 and 2004, average annual temperatures in Alaska have increased by 4°F (Markon, Trainor, & Chapin, 2012). While warmer temperatures may provide benefits to the tourism industry by lengthening the season and shifting demand northward (Albano, Angelo, Strauch, & Thurman, 2013; Amelung, Nicholls, & Viner, 2007), the secondary effects of climate change may negatively impact nature-based tourism operators who rely on climate-sensitive resources (Scott, Jones, & Konopek, 2007). Because climate is the primary driver of change in Southeast Alaska, it is particularly important to develop a better understanding of this linked social-ecological system. Developing this understanding and creating information and communication processes that help build the capacity to adapt to these changes could aid in reducing the vulnerability of the tourism industry to changes in important local resources.

A lack of useful information is a commonly identified barrier in the climate change adaptation process (Moser & Ekstrom, 2010). Unlike some barriers that are more challenging to overcome, climate change outreach efforts are widespread, and identifying relevant communication-related barriers can aid in focusing these existing resources. Engaging stakeholders in a conversation to identify their values, understandings, perceptions, and unique information needs can be a far more effective approach to climate change communication than guessing what an

audience needs (Brossard & Lewenstein, 2010; Nisbet & Scheufele, 2009). To that end, the overarching goal of this study is to determine how best to provide useful climate change information to Juneau, Alaska's nature-based tour operators by answering the following research questions:

1. What environmental changes do nature-based tour operators perceive?

2. How are nature-based tour operators responding to climate and environmental change?

3. What climate change information do nature-based tour operators need?

This research serves an important purpose. Some effort has been dedicated to studying the effects of climate change on some of Alaska's largest industry sectors, such as fishing and oil and gas (Markon et al., 2012). Alaska's tourism industry—comprised of many independent, small and medium sized, Alaskan-owned business—has been largely absent from climate change research and planning efforts. Several recent reports make predictions about the ways that climate change could affect the tourism industry, but there is no indication that these assumptions were developed with tourism industry stakeholders (Haufler, Mehl, & Yeats, 2010; Kelly et al., 2007; Markon et al., 2012; Safford, Henly, & Ulrich, 2013). As a result, there is a limited understanding of the range of environmental variability that tour operators are accustomed to, their degree of adaptive capacity, or how changes in environmental, social, and economic factors are interrelated in the tourism economy. Behind oil and gas, mining, and fishing—tourism is Alaska's fourth largest industry (McDowell Group, 2014). Tourism accounts for only 9% of jobs and 5% of labor income statewide, but it has significant economic value in Southeast Alaska, which has a less diverse economy, is geographically isolated, and has limited access to other natural resources (McDowell Group, 2014; Safford et al., 2013). Understanding how climate change could benefit and harm Alaska's tourism industry is an important step towards developing regional economies

that are resilient to future social, economic, and environmental change.

In the past 50 years, the average annual temperature of Alaska has increased by approximately 4°F (Markon et al., 2012). Increases in temperature have led to reductions in sea ice extent and thickness (Stroeve et al., 2011; Wang & Overland, 2012), glacier mass (Arendt, Walsh, & Harrison, 2009), and permafrost integrity (Markon et al., 2012; Romanovsky, Smith, & Christiansen, 2010). They have also led to increased rates of evapotranspiration, which make the ground dryer and more susceptible to fire (Hinzman et al., 2005; Wolken et al., 2011). Plant, animal, and insect species are moving into new areas as the landscape changes (Markon et al., 2012; Wolken et al., 2011). In the waters surrounding Alaska, temperatures are increasing and the water is becoming more acidic (Markon et al., 2012; Steinacher, Joos, Frolicher, Plattner, & Doney, 2009). Changes in Alaska's physical and biological systems are influencing the availability of and access to ecosystem services and natural resources used by people for life sustaining, economic, cultural, and recreational purposes (Markon et al., 2012; Wolken et al., 2011). It is very likely that Alaska's temperatures will continue to increase (IPCC, 2013; Markon et al., 2012). The magnitude of this change depends on a variety of conditions, but Alaska's physical, biological, social, and economic systems will probably have to adapt to changes in climate throughout the next century.

Like agriculture and other natural resource industries, tourism is climate sensitive. Climate has a direct effect on the times of the year people travel, where they decide to go, when they decide to travel, and the types of activities they choose to participate in (Amelung et al., 2007; Simpson, Gossling, Scott, Hall, & Gladin, 2008). Changes in climate are already creating both opportunities and risks to tourism activities around the world, but research suggests that as temperatures increase, tourism demand is likely to move towards higher elevations and latitudes

and that the length and peak of existing tourism seasons will shift (Amelung et al., 2007). Climate change could positively impact Alaska's tourism industry through increases in demand for high latitude destinations. There is already an indication that Alaska's peak tourism season has lengthened into the shoulder seasons of May and September (Trainor, Walsh, & Yu, 2009; Yu, Schwartz, & Walsh, 2009). Yu and colleagues (2009) found that in the past 50 years the length of the summer tourism season has already increased by 10 days in King Salmon, Alaska.

Climate also has an indirect effect on tourism, by shaping the environment, resources, and infrastructure of a given destination (Simpson et al., 2008). As temperatures in Alaska increase and natural and biological systems change, some of the attractions that define Alaska as a destination and drive tourism demand—such as glaciers, wildlife, and fish—may be at risk (Kelly et al., 2007; Markon et al., 2012). Measuring the direct effects of climate on tourism, as described in the previous paragraph, is relatively simple compared to measuring the indirect effects of climate on tourism. It can be very challenging to accurately predict how physical and biological systems will respond to changes in climate and even more difficult to measure tourists' attitudes towards these kinds of changes.

One approach to studying the indirect or secondary effects of climate change on tourism is to talk to tourism operators about the environmental conditions or changes in those conditions that influence their operations and tourism demand. Like other sources of local knowledge, tourism operators are likely to possess deep understandings of the resources and systems on which they rely. They also understand the intricate relationships between environmental, economic, and social factors that impact their operations' success. Rather than just considering the impacts to resources and the visitor demand for those resources, this approach also takes into consideration tourism operators' perceived capacity to adapt and respond to changing conditions.

Southeast Alaska is an ideal location to undertake a study of this type. While the primary effects of climate change on this region are projected to be less dramatic than in other parts of the state, the secondary effects of climate change on this system could be dramatic. A significant part of the Gulf of Alaska region (~20%) is covered in icefields and glaciers, most of which are losing significant amounts of ice due to rising temperatures (Arendt, 2011; Arendt et al., 2009; Neal, Hood, & Smikrud, 2010). The loss of mass is changing the geography of many glaciers, altering existing view sheds and the access to some glaciers. The amount and quality of glacier runoff influences a wide range of physical and biological processes downstream from glaciers, including ocean currents, water temperatures, and primary productivity in the ocean (Hood & Berner, 2009; Hood et al., 2009; Weingartner, Danielson, & Royer, 2005). All of these factors are important for salmon, marine mammals, and the humans that rely on them (Renner, Arimitsu, & Piatt, 2012; Wolken et al., 2011).

1.2 Study Approach

In Alaska, there is very little prior research on tourism and climate change. Worldwide, many of the climate change adaptation studies from the tourism industry focus on ski tourism. For this study, a primarily qualitative, interview-based approach was selected. The questionnaire developed for the interviews was comprised of mostly open-ended questions, and the interviews were semi-structured to fully gather the information that study participants had to share. This study is intended to provide a broad overview of nature-based tourism operators' perceptions of and response to environmental and climate change. This approach should be particularly useful for generating new hypotheses and informing future research in this area.

Nature-based tour operators are those operators whose activities generally rely on the

natural environment, and the selection of study participants was limited to for-profit, nature-based tour operators based in Juneau, Alaska. As a classifier, nature-based tourism was selected over ecotourism in order to include a greater number of participants in the study. As is the case for most tourism research, this study is fairly context specific. The primary purpose of this study was to identify processes that can be used to inform future research, planning, and outreach efforts in the community. Visitor perceptions and demand, although important factors in the study of tourism and climate, were outside the scope of this particular study. Furthermore, it is widely recognized that tourism affects climate change through the contributions of greenhouse gasses to the atmosphere, but measuring the effects of tourism on climate was also outside the scope of this study. Questions about tourists' attitudes about climate change have come up in conversations and interviews, but measuring these was not included in this research. Because the majority of tourists arrive between May and September, summer tourism was the focus of this study.

1.3 Thesis Structure

This thesis begins with this chapter, Introduction, which provides a general overview of the research problem, study approach, and a reflexivity statement where the author reflects on how she came to work on this subject and any biases she may have introduced to the study. Chapter two, Literature Review, discusses the previous research relevant to the development of this study. This work draws from prior research on climate change, the social-ecological system of Southeast Alaska, tourism and climate, climate change adaptation, and the role of science communication in climate change adaptation. Chapter three, Methods, explains the study site, questionnaire, and steps that were deployed to recruit participants and carry out the research. Chapter four, Results, describes the study participants and the results from each of the three research questions. Chapter five, Discussion, provides an overall discussion of the work and rec-

ommendations for future research and communication and outreach efforts. Chapter six, Conclusions, provides a summary of the results and conclusions.

1.4 Reflexivity Statement

As a child, I spent my summers running around the forests, fields, and lakes that surrounded my rural Wisconsin home. The oldest of my siblings and the other kids in the neighborhood, I also spent my summers generating games, activities, and worksheets to entertain us during our hours outside. Looking back, it's not surprising that I pursued a communication career.

My first real job in communication was at the U.S. Forest Service Begich Boggs Visitor Center, about 60 miles south of Anchorage, Alaska. As an environmental educator and interpreter, my job was to craft messages that helped the listener—the visitors—build emotional connections with the place and the resources. According to the father of heritage interpretation, Tilden Freeman, it was through these emotional connections that one would build knowledge, appreciation, and respect for the resource. Freeman's mantra was, "through interpretation, understanding; through understanding, appreciation; through appreciation, protection."

The main attraction at the Begich Boggs Visitor Center was the Portage Glacier. Like many other glaciers in the region, it has been slowly receding since the last ice age. About 100 years ago, however, a lake began to form at the terminus of the glacier, kick starting a period of rapid recession. The visitor center was built in the 1980s and by the late 1990s, Portage Glacier was no longer visible from the center and had receded beyond a large rock peninsula. You would think that creating emotional connections with an inanimate mass of ice would be challenging, but my job was easy. The sadness that people felt when they realized the glacier was no longer visible from the visitor center and the concern that people had about the rapid recession constant-

ly surprised me.

When I realized that I could pick anything I wanted for my thesis research, my mind wandered back to this interest in human perceptions of environmental change, communication, and glaciers. Aware of the profound impact glaciers had on my understanding of the world and curious about the emotional reaction of the visitors I once interacted with—I wanted to better understand how glaciers shaped peoples' understanding of the world, particularly of climate change. In the 10 years since I had been an interpreter, climate change and global warming had become major topics of public discourse and often central to this discussion—in both words and images—were glaciers.

Through the journey of graduate school, I discovered that some ideas are hard to explain, some don't fit neatly into existing theories, and the way people make sense of the world is messy. I had wanted to study the perceptions of visitors to Alaska, but methodologically it proved to be a particularly challenging endeavor. When the opportunity arose to work with private sector tourism operators and the Southeast Alaska EPSCoR project, I decided to take it. As I prepared for the project, I became more excited because it seemed like the tourism industry was underrepresented in discussions about climate change in Alaska. I anticipated that the tourism operators would have interesting contributions to our understandings of this social-ecological system.

I approached this project much like a communication consultant, brought in to understand an organization and their needs and synthesize what I had learned to produce recommendations. As someone who is admittedly alarmed by the risks posed to myself and other Alaskans by climate change, I am personally interested in how the results of climate change research can be translated to distinct audiences. This is a goal that remains with me even as I complete this

degree and move into my position as a communications specialist with a climate change research and adaptation group at the University of Alaska Fairbanks.

I learned many useful things from the people who participated in my research project. First, I learned that my experiences working in the tourism industry as a federal employee were without the system of overlapping stressors that are constantly present in the private sector, especially for those running their own businesses. My lack of seniority in my position was probably part of this, but the ever-present threat of making enough money to maintain the operation was never a question that I had to face. Running a business puts unique demands on your life, time, and money. After talking with some people I better understood these demands, and I regretted not spending more time developing the relationships with the operators and related industry organizations before embarking on this research. Doing this probably could have improved my study by enabling me to ask more specific research questions and increasing the number of participants. By engaging the tour operators early in the process, the study could have probably produced more relevant results for the tour operators.

I learned another important lesson from the participants of my research project—the power of asking. It is such an easy and simple gesture, but all too often in science communication we fail to ask the question, "what do you want to know?" Many of the participants articulated their appreciation for what I was doing and often noted how I was the first person to ask them what they thought about climate change or what they wanted to know. Particularly for an issue that has become politically charged, we cannot always expect people to tell us what they want. As climate change experts or communicators with connections to experts, we shouldn't be afraid to ask. It is also a means to build a relationship, trust, and respect, and I look forward to bringing this project full circle and sharing my results with the participants of this study.

CHAPTER 2
LITERATURE REVIEW

2.1 Climate Change

Anthropogenic contributions of carbon dioxide (CO2) into the atmosphere have led to an increase in the global average temperatures of Earth (IPCC, 2013). Instrumental records indicate that between 1820-2012 the global average land and ocean surface temperatures have increased by .85°C (IPCC, 2013). Paleoclimate records obtained from sediment cores, tree rings, and ice cores reveal that the levels of greenhouse gasses, including carbon dioxide (CO2), methane (CH4), and nitrous oxide (NO2), in our atmosphere are greater now than in the past 800,000 years (Masson-Delmotte et al., 2013). In the Northern Hemisphere, the past 30 years was likely the warmest 30-year period in the past 1400 years (IPCC, 2013). Contributions of CO2 into the Earth's atmosphere are not significantly declining, and global temperatures are expected to continue to increase during the next century (IPCC, 2013).

The Arctic is warming much more rapidly that the rest of the planet (Serreze & Barry, 2011). In the past 50 years, Alaska's temperatures have increased at nearly double the rate of states at lower latitudes (Markon et al., 2012). Between 1949 and 2004, average annual temperatures in Alaska increased by 4°F (Markon et al., 2012). Warming has disproportionately affected the winter months; in the past 60 years average winter temperatures across Alaska have increased by 5.8°F (Stewart, Kunkel, Stevens, Sun, & Walsh, 2013). For the same time period, average spring and summer temperatures increased by approximately 3°F (Stewart et al., 2013). By the middle of this century, the average annual mean temperature of Alaska is expected to warm by an additional 4-6°F (Stewart et al., 2013).

Between 1949-2005, precipitation increased by 10% in Alaska (Markon et al., 2012). Precipitation is projected to increase in the next 30-80 years, with the greatest changes projected to occur in Northwest Alaska and the smallest changes in Southeast Alaska (Markon et al., 2012; Stewart et al., 2013). At lower elevations and in more temperate regions of the state, changes in the amount of snow falling as rain or rain/snow mixtures may become more common as temperatures increase (McAfee, Walsh, & Rupp, 2013). On average, warming temperatures are causing Alaska's snow cover to begin approximately 2 days later and melt approximately 2-6 days earlier (Markon et al., 2012). While more precipitation may fall, increasing temperatures will lead to increased rates of evapotranspiration, making water less available in some regions (Hinzman et al., 2005).

Alaska covers approximately 1.7 million square kilometers (663,300 square miles) and possesses a lot of climatic and geographic diversity. Because of this, changes in temperature and precipitation are leading to a wide variety of different impacts (Stewart et al., 2013). The extent and thickness of arctic sea ice has been steadily declining, and summer sea ice is expected to disappear by the middle of this century (Stewart et al., 2013; Stroeve et al., 2011; Wang & Overland, 2012). The mass of Alaska glaciers has decreased rapidly in the past 30 years (Arendt, 2011) and is expected to continue (Radić et al., 2013). Alaska glaciers will continue to make significant contributions to global sea level rise (Arendt et al., 2013; Arendt et al., 2009; Berthier, Schiefer, Clarke, Menounos, & Rémy, 2010). Permafrost temperatures are increasing, leading to land subsidence, changes in hydrologic systems, and changes to ecosystem processes (Romanovsky et al., 2010). Dryer ground is more susceptible to fire, and is leading to the northward expansion of some shrub and tree species (Hinzman et al., 2005; Wolken et al., 2011).

Alaska has more coastline than the other U.S. states combined, and the impacts of climate

change on the ocean will also be very important to the state. Ocean temperatures are increasing, and some marine species are moving northward in response (Markon et al., 2012). Because of the cold water temperature, large freshwater inputs, and proximity to global ocean circulation patterns, Alaska's waters are experiencing increased rates of ocean acidification (Steinacher et al., 2009). The changing chemistry of the ocean may affect marine organisms across the food chain, but the vulnerability of specific species to ocean acidification is still largely unknown (Mathis, Cross, & Bates, 2011). Fall storms—common in the Bering Sea—are posing greater threats to communities who no longer have the protection of coastal sea ice and permafrost to stabilize their coastlines (Markon et al., 2012).

The people and economy of Alaska are closely connected to the natural environment, and climate change has the potential to create both opportunities and risks to social-ecological systems. For example, oil and gas is the largest economic sector in Alaska, and exploration of and transportation to these resources could be positively impacted by the loss of sea ice or negatively affected by the loss of frozen ground for ice roads and other infrastructure (Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska, 2013; Markon et al., 2012). Marine species, such as salmon, might be negatively affected by increases in ocean temperatures and other species, such as crab, might also be affected by changes in ocean chemistry (Orr et al., 2005). This could have devastating impacts on commercial and subsistence fisheries in some areas (Long, Swiney, & Foy, 2013; Markon et al., 2012). Changes in climate may cause some subsistence plant and animal species to shift their ranges, making access to these culturally and economically important food sources challenging for some communities or easier for others (Markon et al., 2012; Wolken et al., 2011). Many climate change threats have been identified, yet there will always be some uncertainty about how complex and interconnected

natural and social systems will respond.

2.2 Social-Ecological System of Juneau, Alaska

Social-ecological systems are systems where biophysical and social processes interact with each other across varying temporal and spatial scales (Chapin, Kofinas, & Folke, 2009). Within this system, humans both influence and depend on specific resources and ecosystem services (Figure 1)—or the benefits that humans receive from the environment (Chapin et al., 2009). The benefits that ecosystem services provide to society can include things like a tolerable climate, clean water, or soil to grow food. They can also include nonmaterial benefits, such as aesthetically pleasing landscapes or recreational opportunities. Generally, ecosystem services fall into four categories: supporting, provisioning, regulating, and cultural services. Ecosystem services are often managed and capitalized on by humans to maintain a certain degree of wellbeing, and as such, they provide a useful framework for analyzing multiple drivers of change in social-ecological systems.

The focus of this study is the social-ecological system encompassing the community of Juneau, located in the Southeast region of Alaska—a long, narrow region of the state residing west of the Canadian province of British Columbia and to the east of the Gulf of Alaska (Figure 2). Juneau is located on the Gastineau Channel, separated from the Gulf of Alaska by several large islands. Juneau is surrounded by the mountains of the Coast Range, which are bisected by several large icefields, glaciers, and fiords. The dramatic geography of the region creates a lot of climatic diversity and microclimates, but the dominant ecosystem is the Northern coastal temperate rainforest (Shulski & Wendler, 2007).

In 2011, Juneau (city and borough) had approximately 31,000 residents (Safford et al.,

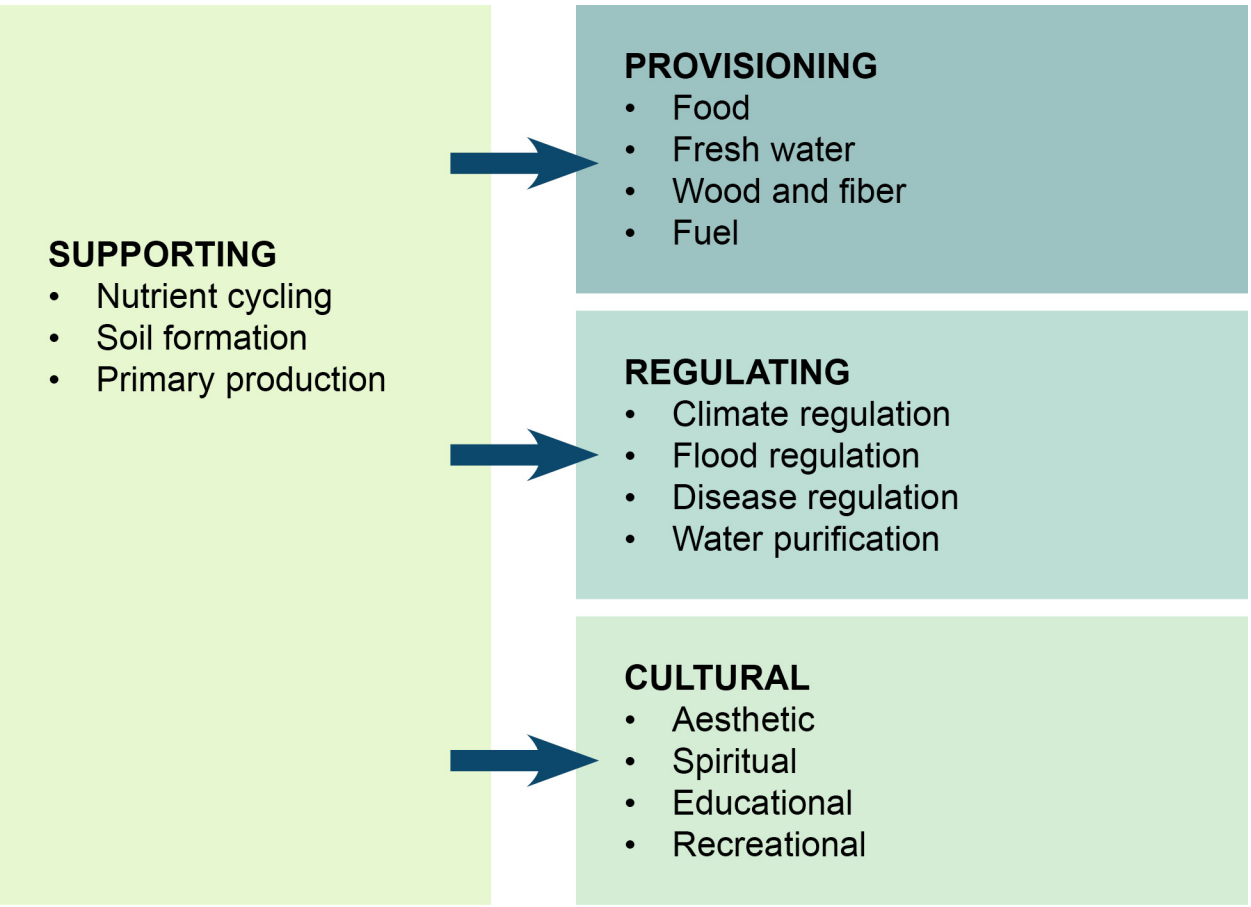


Figure 1. Ecosystem Services.

Ecosystem services are the benefits that people obtain from ecosystems. They include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other services. Ecosystem services are the benefits that people obtain from ecosystems. They include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other services.

2013). Without a road into the city, it is geographically isolated and only accessible by air or water. Nonetheless, Juneau hosts approximately one million out of state visitors each year, who primarily arrive via cruise ship (McDowell Group, 2012; Safford et al., 2013). Tourism, fishing, and employment in the government sector are the primary drivers of Juneau's economy (Safford et al., 2013). Nearby communities have seen recent declines in forestry and fishing jobs, and continued development of the tourism industry has been identified as a crucial element for economic success in the region (Safford et al., 2013).

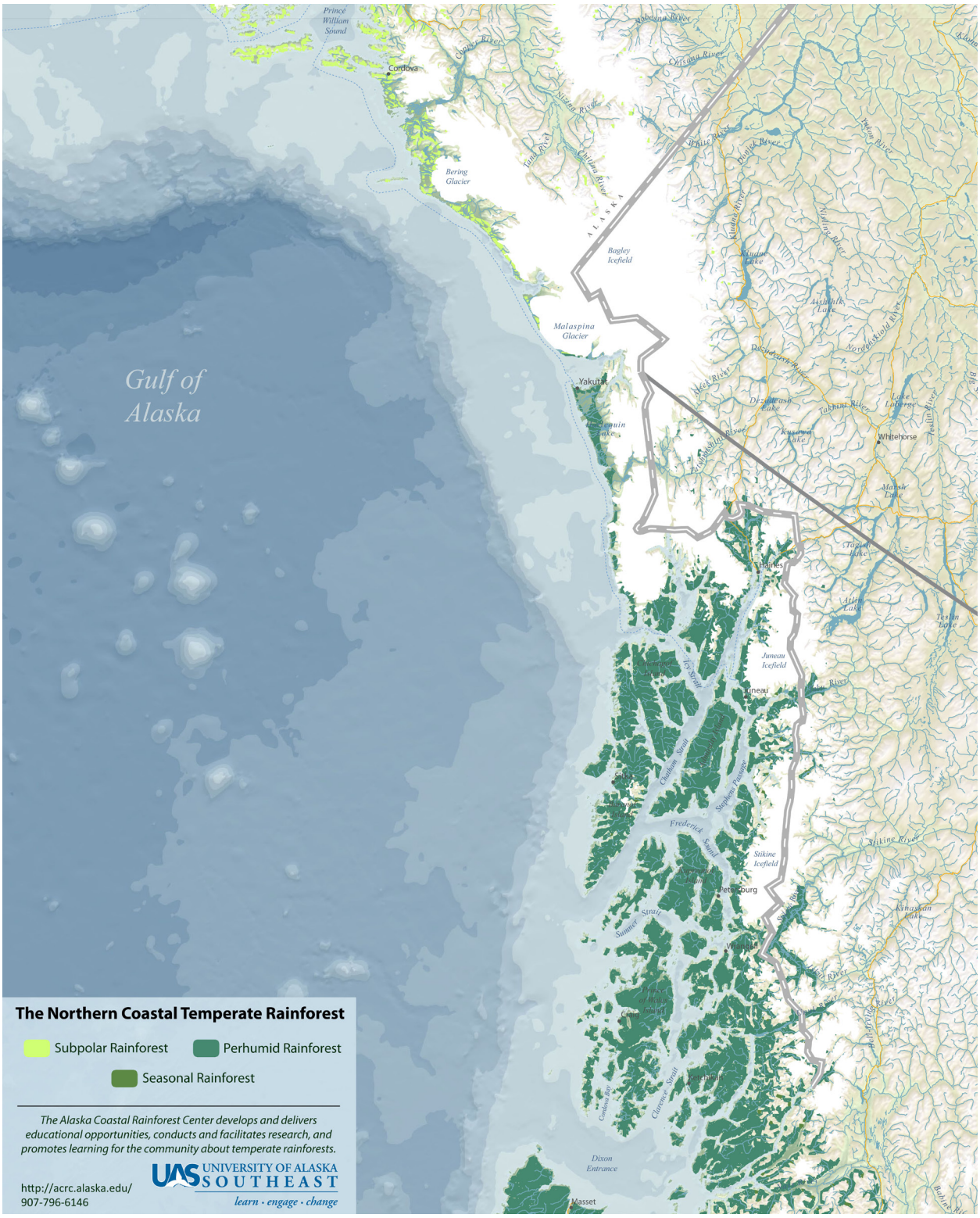


Figure 2. Map of Southeast Alaska.

The southern panhandle of Alaska is mountainous, bisected by several large icefields and hundreds of glaciers, and is part of the Northern coastal temperate rainforest (Map courtesy of the Alaska Coastal Rainforest Center).

Representative of much of Southeast Alaska, Juneau has a maritime climate with cool summers and warm winters. The average annual temperature is 5.6° C (42°F), and the winter highs are rarely below freezing (Shulski & Wendler, 2007). Average annual quantities of precipitation vary considerably across the Juneau area, with approximately 58 inches (1473 mm) of precipitation at the airport and 86 inches (2184 mm) downtown, just a few miles away (Shulski & Wendler, 2007). Nearly 100 inches of snow falls on Juneau annually, but very little (less than 10 inches) is on the ground at any given time due to the warm temperatures near sea level (Shulski & Wendler, 2007). Nearby higher elevation locations can receive over 100 feet of snowfall in a year (Kelly et al., 2007).

Between 1949-2011, the average annual temperature of Juneau has increased by 3.1° F (Stewart et al., 2013). The greatest increases in temperature have occurred during the winter months—a 6.4°F increase (Stewart et al., 2013). Climate models suggest that by the end of the century, average temperatures in Juneau could increase by an additional 6-8°F (Figure 3) (Stewart et al., 2013). A slight increase in precipitation is also likely during the next century (Figure 4). Precipitation is sensitive to slight changes in temperature, and even a small increase in winter temperatures could lead to greater amounts of rain and less snow—especially at lower elevations (Kelly et al., 2007; McAfee et al., 2013). Historical precipitation data for higher elevations is limited and there are many microclimates throughout the region, which makes modeling precipitation particularly challenging (McAfee et al., 2013).

Warmer temperatures and changes in precipitation could have many impacts on Southeast Alaska. In the terrestrial landscape, these changes are causing the ranges of some plants and animals to shift and threatening the viability of others. Western red cedar and Douglas fir are expected to move northward, while Sitka spruce and mountain hemlock are expected to move to higher

elevations (Kelly et al., 2007). Yellow-cedar is already experiencing population declines, because the trees' roots are vulnerable to freezing when there is insufficient insulating snow cover in the early spring (Kelly et al., 2007). Insect species, especially those that affect commercially important coniferous trees, are moving northward (Kelly et al., 2007). With more standing dead timber, fire may become a part of this system where it has traditionally been quite rare (Kelly et al.,

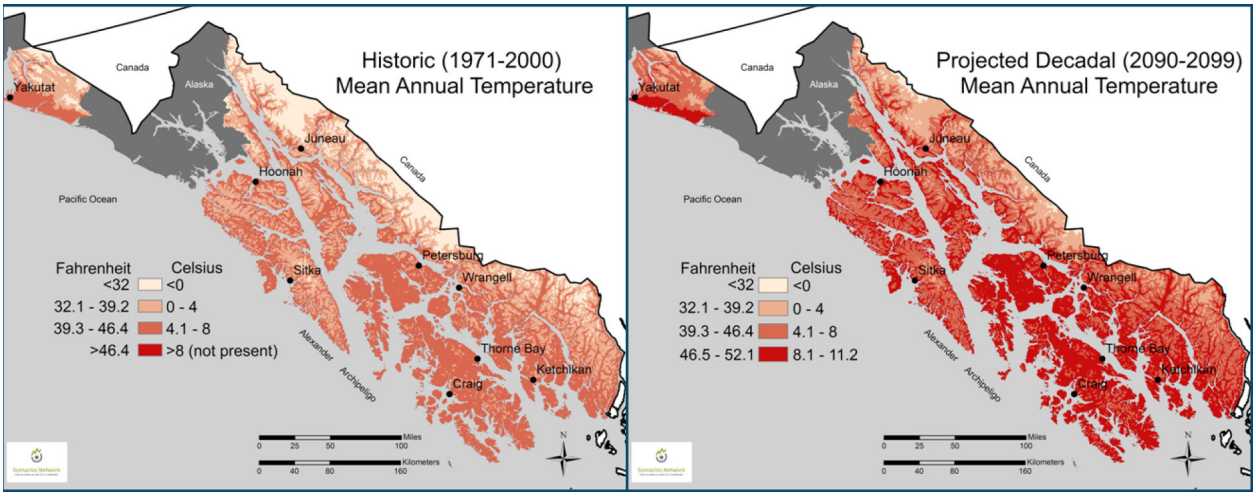


Figure 3. Historic and Projected Mean Annual Temperatures in Southeast Alaska.

Mean annual temperatures in Southeast Alaska could increase by an additional 6-8° F by the end of this century (Figure by Scenarios Network for Alaska and Arctic Planning and courtesy of the Alaska Coastal Rainforest Center).

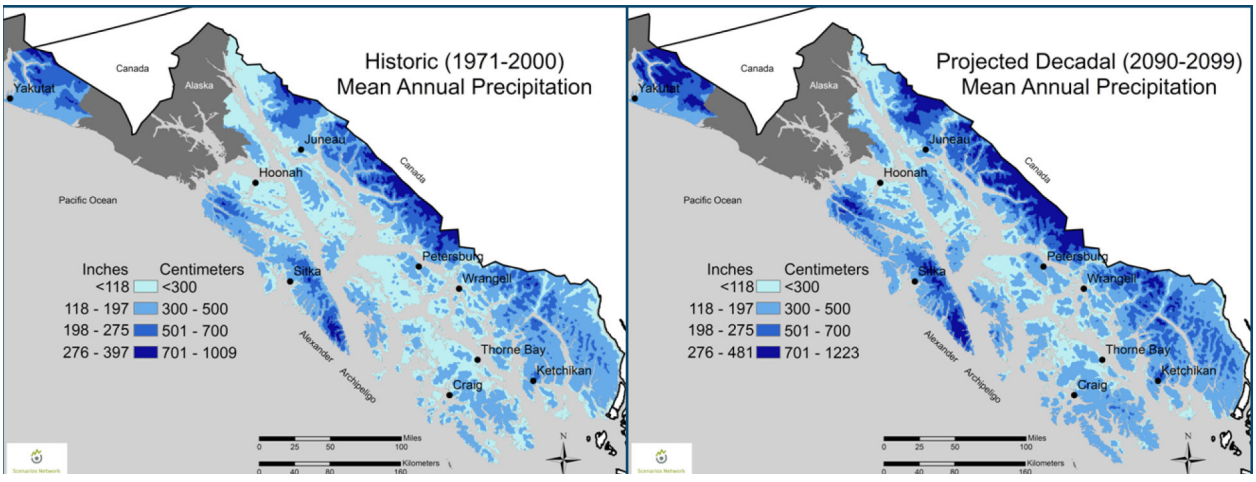


Figure 4. Historic and Projected Mean Annual Precipitation in Southeast Alaska.

Slight increases in precipitation may be observed in some regions of Southeast Alaska during the next century (Figure by Scenarios Network for Alaska and Arctic Planning and courtesy of the Alaska Coastal Rainforest Center).

2007). All of these factors affect the provisioning ecosystem services that support logging as well as the aesthetic and recreational ecosystem services provided by the wilderness character of the landscape.

Perhaps most significantly, changes in temperature and precipitation are affecting the ice-fields and glaciers that dominate this region. Since the end of the Little Ice Age in the late 1700s, Alaska glaciers have been stable or slowly declining (Barclay, Wiles, & Calkin, 2009; Kelly et al., 2007). Since the 1960s, however, the majority of Alaska glaciers have been losing mass and the rate of the mass loss accelerated in the mid-1990s (Arendt et al., 2013; Arendt et al., 2009). Glaciers currently cover about 20% of the land area surrounding the Gulf of Alaska (Neal et al., 2010). While it is unlikely that Southeast Alaska glaciers will completely disappear during the next century, a 9-49% reduction in glacier mass is projected for this region (Radić et al., 2013). Depending on the specific glacier, the loss of mass may be expressed geographically by terminus retreat, glacier thinning, and/or the formation of a proglacial lake (Larsen, Motyka, Arendt, Echelmeyer, & Geissler, 2007). These changes affect the character of the landscape and the aesthetic and recreational ecosystem services currently provided by many Southeast Alaska glaciers.

Changes in the existence of glaciers, their locations, and runoff could have substantial impacts on regional hydrology. About 50% of the freshwater that drains into the Gulf of Alaska comes from glaciers (Neal et al., 2010). Glacier runoff has distinct physical and biological characteristics. It is a source of organic carbon (Hood et al., 2009), phosphorus (Hood & Scott, 2008), and iron (Schroth, Crusius, Chever, Bostick, & Rouxel, 2011)—elements that support primary productivity in estuaries and other marine ecosystems. By providing the nutrients and minerals that support primary productivity, there is some evidence to suggest that tidewater glaciers and glacier runoff is an important factor for the health of several marine organisms, especially harbor

seals and Kittlitz's murrelets (Renner et al., 2012). Many marine species are valuable to society for their commercial, recreational, or subsistence value, and the linkages between glacier change and fish and wildlife species is an area of ongoing research.

Glacier change in Alaska can also have impacts beyond the region. Differences in temperature and salinity of glacier runoff helps to drive the Alaska Coastal Current (Stabeno et al., 2004; Weingartner et al., 2005). This current carries nutrients northward into the productive fisheries of the Bering Sea. Alaska glaciers are also making significant contributions to global sea levels. In the past few decades, Alaska glaciers have contributed enough runoff to increase global sea level by .004 to.007 in/year (Arendt et al., 2013). Sea level rise is not, however, impacting Southeast Alaska. Throughout southern Alaska, the loss of glacier ice is causing the Earth's surface to slowly rebound. The uplift is occurring at a rate of about .4 in/year or more and is negating regional sea level rise; in Southeast Alaska sea level is actually decreasing at a rate of .04 to 07 inch/year (Kelly et al., 2007; Markon et al., 2012).

2.3 Nature-Based Tourism and Climate

In Southeast Alaska, many of the natural processes and systems that have been identified as being impacted by or vulnerable to climate change are also some of the most important tourist attractions. A 2011 survey conducted for the Alaska Travel Industry Association found that over 90% of potential visitors are motivated to visit Alaska because of its glaciers and fjords, wildlife, mountains, and state and national parks (GMA Research Corporation, 2011). Several reports about climate impacts in Alaska have suggested that changing temperatures, snow cover, glaciers, wildlife and fish populations, and climate impacts on infrastructure have the potential to negatively impact tourism (Haufler et al., 2010; Kelly et al., 2007; Markon et al., 2012; Safford

et al., 2013). There have been very few studies, however, to try to gauge the severity of these environmental changes for Alaska's tourism sector.

Tourism throughout Alaska, but especially in Southeast Alaska relies heavily on the natural environment (Dugan, Fay, & Colt, 2006). Nature-based tourism is a term used to describe tourism activities where the natural environment is a significant input. Nature based tourism is defined by Hall and Boyd (2005, p. 3) as, "tourism in natural settings (e.g. adventure tourism), tourism that focuses on specific elements of the natural environment (e.g. safari and wildlife tourism, nature tourism, marine tourism), and tourism that is developed in order to conserve or protect natural areas (e.g. ecotourism, national parks)."

Climate and tourism, especially nature-based tourism, are inextricably linked (Simpson et al., 2008). Tourism affects climate, through the contributions of greenhouse gasses to the atmosphere (Fischer, 2007). More relevant to this particular study, however, climate has direct and indirect effects on tourism. As a direct effect, climate is a primary resource for tourism. Climate produces a "pushing" effect that motivates people to leave their origin in search of more desirable conditions (Amelung et al., 2007). It also has "pulling" influence on the demand and attractiveness of a destination, the length and peak of the season in which tourism activities generally occur, and the types of activities that visitors are likely to participate in (Amelung et al., 2007; Simpson et al., 2008). Climate also has an indirect effect on the environment, resources, and infrastructure of a given destination (Simpson et al., 2008). Although price and economic factors probably have a stronger effect on peoples' decision to travel to a given destination, both the direct and indirect effects of climate are also important factors in shaping demand and destination choice (Lohmann & Kaim, 1999).

Similar to agriculture, tourism has been described as a climate-sensitive activity (Amelung et al., 2007; Simpson et al., 2008). One of the most well documented effects of climate change on tourism is occurring in the ski industry. Several studies have documented how the length of the ski season in Europe and North America is shortening and how snowpack has been decreasing or completely absent some winters (Burakowski & Magnusson, 2012; Elsasser & Bürki, 2001; A. Fischer, Olefs, & Abermann, 2011; Koenig & Abegg, 1997; Trawöger, 2014). In Alaska, Yu and colleagues (2009) found that the Anchorage area ski season ends about nine days earlier than in the 1940s.

While some winter destinations suffer from shortened seasons, other destinations are benefitting from warmer temperatures that extend the peak season (Scott et al., 2007). Some researchers suggest that increased numbers of people will choose destinations at higher altitudes and latitudes and that peak seasons will shift as people seek relief from warmer temperatures at lower latitudes (Amelung et al., 2007; Bigano, Hamilton, & Tol, 2006). In Alaska, the vast majority—about 85%—of out of state visitors arrive between May and September (McDowell Group, 2012). Climate change could have some benefits for Alaska by extending the length of the season and attracting greater numbers of visitors. One study used historical climate records and visitation numbers to investigate how warming temperatures impacted the length of the summer visitation season in King Salmon, Alaska, and found that changes in climate lengthened the visitation season by 10 days since the 1940's (Yu et al., 2009). Albano and colleagues (2013) used downscaled climate models and visitor numbers to create visitation projections for Alaska's Katmai, Denali, and Gates of the Arctic National Parks. Although the exact number of days varied depending on the climate scenario and time period, they found that changes in climate could shift peak tourism seasons for each of the locations further into the current shoulder seasons of

May and September (Albano et al., 2013). Last chance tourism—the idea that destinations gain popularity because they are perceived to be disappearing or dramatically changing—may actually draw more visitors to Alaska too (Lemelin, Dawson, Stewart, Maher, & Lueck, 2010).

The indirect effects of climate on tourism attractions, activities, and infrastructure have not been studied as thoroughly as the direct effects. In his review of the literature, Fischer (2007) attributes this to extensive climatic, environmental, and social variability that exists between destinations. The high degree of uncertainty in climate impacts, magnitudes, and human response also makes it more challenging to document and predict the indirect impacts of climate change on the tourism industry. In one study, Scott and colleagues (2007) tried to measure visitor perceptions of the indirect effects of climate change on tourism by surveying park visitors about their preferences for certain environmental conditions. The characteristics of future conditions (size of glaciers, numbers of wildlife, range of plant species, etc.) were categorized into three scenarios representing future time periods (2020s, 2050s, and 2080s). Respondents least preferred the scenario for the 2080s, but the authors admit that the high degree of uncertainty in the scenarios are problematic for this methodology (Scott et al., 2007). Furthermore, tourists assessed the scenarios using the present as a baseline, so it wasn't surprising that more dramatic impacts of the 2080s scenario were found less favorable than those in 2020s scenario (Scott et al., 2007). Similar work has not been done in Alaska, but there are clearly some issues with using this particular line of inquiry.

An alternative approach to studying the indirect effects of climate on tourism is to talk to tourism operators about the environmental conditions that influence their operations. Like other sources of local knowledge, tourism operators can possess deep understandings of the resources on which they rely. There are many assumptions about the ways climate change could negatively

impact Alaska's tourism resources, including the disappearance of glaciers and more difficult access to glacier viewing, reduced fish populations for sport fishing, and shifting ranges or population changes in key wildlife species such as bears or whales (Haufler et al., 2010; Kelly et al., 2007; Markon et al., 2012; Safford et al., 2013). While these reports identify potential risks, there has not been any research to document the extent to which the tourism industry could adapt.

Accounting for 9% of the state's employment and $1.24 billion dollars of labor income, tourism is the fourth largest industry in Alaska (McDowell Group, 2014). Developing an understanding of how climate change is directly and indirectly affecting tourism, and how tourists and tourism operators are responding and adapting is an important area for further research. Studies from other places around the world have shown that tourists themselves are highly capable of adapting to the impacts of climate change, but they adapt by selecting new destinations, changing the timing of activities, or adopting new recreational interests (Fischer, 2007; Scott & McBoyle, 2006). Tour operators, especially those small to medium sized, locally-based, and resource dependent businesses, tend to be closely linked to one location and less mobile (Fischer, 2007; Scott & McBoyle, 2006). Although it may be more challenging to adapt, tourism operators have developed a wide range of strategies to adapt to changing environmental conditions. Scott and McBoyle (2006) documented the ways that ski areas were adapting to climate change, including snowmaking, cloud seeding, creating resort conglomerates, and diversifying the activities offered by their business.

2.4 Climate Change Adaptation

Adaptation is the ability of a system to adjust to change (Chapin et al., 2009). The origins of adaptation are in the natural sciences, but it has come to be widely used in the discourse of

social-ecological systems and climate change research (Chapin et al., 2009; Moser & Ekstrom, 2010; Smit & Wandel, 2006). The IPCC (2007) defines adaptation as, "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities." Moser and Ekstrom (2010) have a slightly different definition of adaptation in social ecological systems. They define it as, "the change in social-ecological systems in response to actual and expected impacts of climate change in the context of interacting nonclimatic changes." They go on to describe how adaptation strategies and actions can range from short-term coping to longer-term, deeper transformations, aim to meet more than climate change goals alone, and may or may not succeed in moderating harm or exploiting beneficial opportunities. This is a pretty broad definition, but in many instances it can be challenging to separate climatic stimuli from other factors (Adger, Arnell, & Tompkins, 2005). Furthermore, climate change is rarely the sole motivation for people to adapt to a given stimulus—people adjust their behavior to a wide range of perceived risks or changes in resource availability (Adger et al., 2005; Berrang-Ford, Ford, & Paterson, 2011).

Adaptation can be subtle—a response to past or current events, or it can be a strategy for responding to a future situation (Adger et al., 2005). The IPCC (2007) identifies three types of adaptation behaviors. Anticipatory or proactive adaptation occurs before the impacts of climate change are detected. Autonomous adaptation is not a conscious response to climatic stimuli, but rather a decision affected by any detected changes in natural or social systems. Autonomous adaptation often involves expanding or intensifying existing risk management activities, such as increasing water storage in a drought-prone landscape (IPCC, 2007). Planned adaptation is a deliberate decision to act and includes an awareness that the conditions have or will change and that action is required to attempt to maintain a given state (IPCC, 2007; Moser & Ekstrom,

2010).

Several different disciplines have created process models that establish a series of steps or phases in the adaptation process (Moser & Ekstrom, 2010; National Research Council, 2010; Reser & Swim, 2011). While they vary slightly, they all tend to have some similar characteristics (Figure 5). Adaptation tends to begin with the identification of a relevant problem or risk. During this phase, a minimum threshold of issue concern or problem recognition must occur before resources (time, money, etc.) are dedicated or a response is initiated (Moser & Ekstrom, 2010; Reser & Swim, 2011). After a risk has been detected, it is assessed in context to determine the degree of vulnerability and the capacity to respond (National Research Council, 2010; Reser & Swim, 2011). Next, options or strategies are developed and selected (Moser & Ekstrom, 2010; National Research Council, 2010). Finally, choices are implemented, monitored, evaluated, and potentially reassessed (Moser & Ekstrom, 2010; National Research Council, 2010). It's rare that

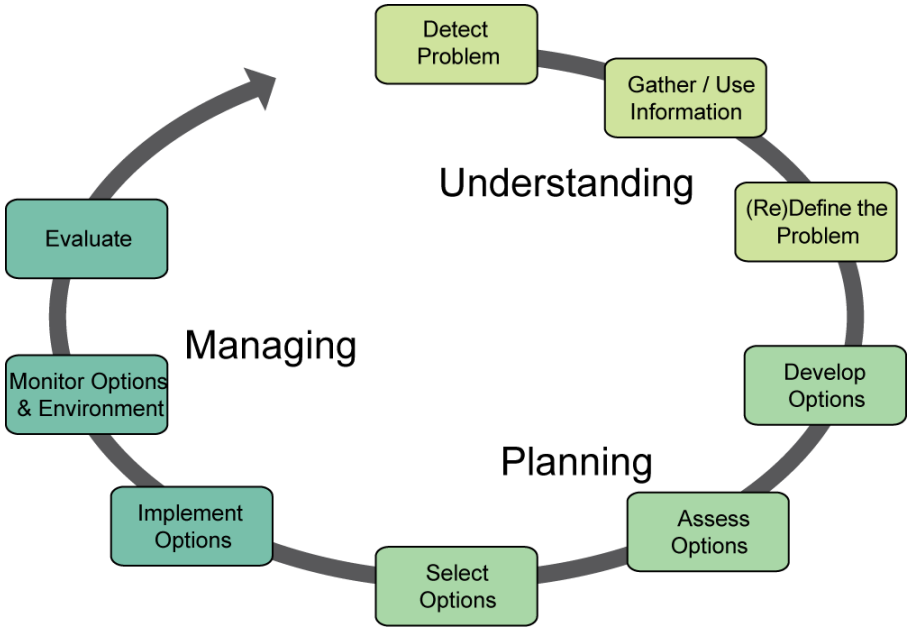


Figure 5. Phases of the Adaptation Process.

The common phases of the rational decision-making process applied to climate change adaptation as a foundation for identifying barriers in the climate change adaptation process (Adapted from Moser & Ekstrom, 2010).

any given adaptation effort follows a process model precisely, but it does provide a useful means to discuss where organizations are in the adaptation process and to diagnose any barriers in the process (Moser & Ekstrom, 2010).

Barriers are obstacles in the adaptation process, which can be overcome with concerted effort, creative management, change of thinking, prioritization, and related shifts in resources, land uses, and institutions (Moser & Ekstrom, 2010). Barriers can be incredibly unique, even between seemingly similar organizations (Archie, 2013; Archie, Dilling, Milford, & Pampel, 2012; Biesbroek, Klostermann, Termeer, & Kabat, 2013; Finzi Hart et al., 2012). In and of themselves, adaptation barriers can be very diverse, spanning issues of policy, leadership, operating budgets, personnel, information, individually held beliefs, and perceptions of risk (Archie, 2013; Moser & Ekstrom, 2010). An increasing amount of research has been dedicated to looking at the adaptation efforts and barriers perceived across a wide range of institutions (Archie, 2013; Archie et al., 2012; Finzi Hart et al., 2012; Moser, 2012; Moser & Ekstrom, 2012). As a relatively new area of research, the types of barriers have had little systematic organization across the literature (Biesbroek et al., 2013).

Across the various organization types, participants of past studies have identified a range of barriers related to information and communication processes, such as a lack of consensus on the importance of climate change or insufficient staff resources to analyze information (Archie, 2013; Archie et al., 2012). They have also described problems with the information itself, such as a lack of access to useful information (Archie et al., 2012; Finzi Hart et al., 2012; Kiem & Austin, 2013) or feeling like the information was too uncertain (Berkhout, Hertin, & Gann, 2006). In their review of the literature, Biesbroek and colleagues (2013) note that there is an impressive number of barriers that have been reported but little empirical evidence on interventions to over-

come climate change adaptation barriers.

Communication and information are frequently cited barriers, yet there is an extensive and growing body of research on science and climate change communication that could help resolve these barriers. Applying the science communication research to overcome communication and information-related barriers may require few additional resources—just a better use of the resources already allotted to outreach. Many agencies, non-profits, and research organizations are putting extensive effort into informing stakeholders about climate change and aiding in adaptation planning. Barriers can be challenging to overcome, but developing a better understanding of specific barriers can improve the use of resources for adaptation planning (Moser & Ekstrom, 2010; National Research Council, 2010). Improving communication and information for climate change adaptation could lead to significant improvements in the way that our society prepares for the impacts of climate change.

2.5 The Role of Communication in Climate Change Adaptation

Adaptation in social systems requires learning, experimenting, deliberation, and communication (Adger et al., 2008; Chapin et al., 2009). Communication and information are ongoing needs of the climate change adaptation process, but climate change is an inherently a challenging subject to communicate (Hulme, 2009; Moser, 2010). Climate is an abstraction, and the physical phenomena and systems that effect climate are complex and difficult for most people to understand (Moser, 2010). The causes of climate change are largely invisible, and for many Americans the signals and impacts of climate change are invisible or difficult to attribute to climate change (Moser, 2010; Weber & Stern, 2011). Because of the long residence of greenhouse gasses in the atmosphere, self efficacy to address climate change tends to be low and gratification for any

changes in behavior are likely to be non-existent or delayed (Moser, 2010; Weber & Stern, 2011). The future impacts and magnitudes of climate change are wrought with various types of uncertainty, which makes climate change challenging to translate into tangible ideas (Hulme, 2009; Moser, 2010; Weber & Stern, 2011). Like the anti-smoking campaigns of the 1990s, climate science has also been the victim of an active and well-funded misinformation campaign (Weber & Stern, 2011). The list of reasons that climate change is difficult to communicate is notable and extensive.

Unfortunately, the approach that has most frequently been used to communicate about climate change has not helped to advance public understanding and urgency. Unlike the field of health communication where communication research and practice were closely connected from the start, early climate change communicators were largely unfamiliar with the social science research that was being conducted and communication research was doing little to prepare the practitioners (Moser, 2010; Nisbet, 2010). As a result, the dominant paradigm for climate change communication has been the deficit model. In the deficit model of science communication, the audience is perceived to be lacking a specific type of knowledge and the purpose of science communication is to convey information to fill this deficit (Brossard & Lewenstein, 2010; Nisbet & Scheufele, 2009). When the facts do not sufficiently change public opinion or elicit a desired behavior, the failure of the communication is often blamed on the illiterate or irrational public or mass media errors or misrepresentations, rather than the potential mistakes of the individuals attempting to communicate the science (Brossard & Lewenstein, 2010; Nisbet & Scheufele, 2009). Striving for greater education and increases in scientific literacy are valuable endeavors, but it is overly simplistic to assume that transferring information is all that is needed to make people think something in particular or behave in a certain way (Moser, 2010).

The deficit model is not supported by communication research (Brossard & Lewenstein, 2010; Nisbet & Scheufele, 2009). If this model were accurate, there would be increases in scientific literacy during periods of greater investment in scientific outreach. Instead, scientific literacy has remained mostly steady through time (Brossard & Lewenstein, 2010). Communication is process of negotiating meaning, and because of this information must be communicated in ways that recognize the values and worldviews of the audience (Nisbet, 2010). Research shows that when subject matter is made personally relevant, even people with limited scientific backgrounds or formal education can grasp complex concepts (Brossard & Lewenstein, 2010). Furthermore, people rely on their values to identify issues of importance and to choose ideologically congruent interpretations of those issues (Kahan et al., 2012; Nisbet, 2010). Kahan and colleagues (2012) found that with climate change and other politically charged scientific subjects, people consistently shape their opinions to maintain consistency with the dominant values of their cultural group. As scientific literacy increases, individuals who value individualism—an attitude that prefers individual freedom of action over collective control—actually perceived climate change to be a lower risk than those with lower scientific literacy (Kahan et al., 2012). In short, knowledge is only one of many factors that people use to consider or make decisions on scientific information or issues, and it is often not the most important factor.

Understanding what is known about climate change communication, several scholars have suggested that a public engagement and user-centered model of communication should be pursued (Brossard & Lewenstein, 2010). This model of science communication is based on the widely accepted idea that communication is not a one-way transmission of information, but rather a relational process of creating and interpreting messages (Nisbet, 2010). Communication is relational, in that the meaning of a particular message can only be ascribed to a message

if two or more people are involved in a communication act. The communicator makes conscious choices as they craft a message. The listener will interpret the message based on their values, experiences, knowledge, culture, etc. The way the listener interprets the message—regardless of the speaker's intent—is what shapes the response, whether it is a new message, a question, a decision, or a behavioral action.

Underlying worldviews and beliefs shape how people understand climate change information, evaluate the risks, and the ways they chose to respond (Hulme, 2009; Kahan et al., 2012; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Pelletier & Sharp, 2008). As such, effective communication begins with developing an understanding of the audience (Moser, 2010). Researchers have developed survey instruments to measure climate change beliefs, behaviors, and policy preferences of individuals nationally and internationally. The results of one study have been used to identify "Six Americas", or six distinct groups of people with respect to their climate change beliefs, behaviors and policy preferences (Figure 6) (Maibach, Leiserowitz, Roser-Renouf, & Mertz, 2011b). The groups differ based on four main climate change beliefs, including climate change is real, it's human caused, it's bad for people, and it's solvable (Roser-Renouf, Stenhouse, Rolfe-Redding, Maibach, & Leiserowitz, in press). Based on their characteristics, associated message frames have been developed for each group (Roser-Renouf et al., in press). For example, Roser-Renouf and colleagues (in press) describe how members of the Alarmed group already understand the science and are most interested in information about how to respond. They also discuss how members of the Cautious group pay little attention to climate change, and the messages intended for this group should aim to capture the audience's attention.

An understanding of the audience can be used to specially frame information. As a concept, framing has a diverse academic background and has been applied in critical, sociological,

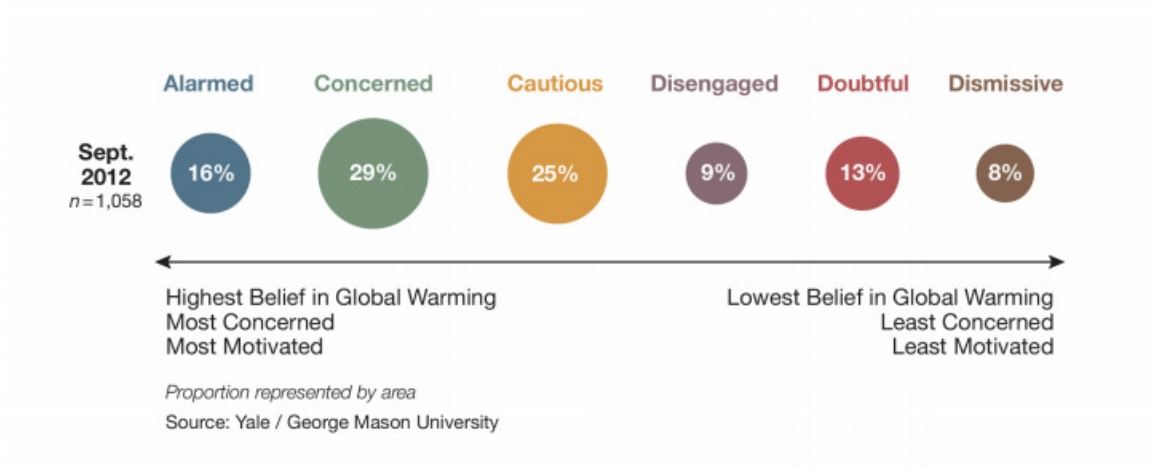


Figure 6. Global Warming's Six Americas in September 2012.
Since 2008, researchers at Yale and George Mason University have tracked the beliefs, behaviors, and policy preferences of Americans through national surveys (Leiserowitz, Maibach, RoserRenouf, Feinberg & Howe, 2013).

economics, psychology, political science, media studies, and in communication (Borah, 2011). Because of these diverse backgrounds, framing also has many definitions, but in general, it is a communication technique where emphasis is placed on the aspects of information that are most relevant to a given audience. Entman (1993) describes that, "to frame is to select some aspects of perceived reality and make them more salient when communicating, in such a way to promote a particular problem definition, causal interpretation, moral evaluation, or treatment recommendation for the item described."

Within the framing literature, several dominant frames exist, and they have been studied in both applied and laboratory settings. The dominant frames are constructed around ideas like social progress, morality, or conflict (Nisbet, 2010). There are also issue specific frames, and for the issue of climate change, many different frames are emerging and being tested. Many of these studies have come to a similar conclusion that most people prefer climate change to be framed as a local rather than a global issue (O'Neill & Hulme, 2009; Scannell & Gifford, 2011; Schweizer,

Davis, & Thompson, 2013). This particular message frame has the potential to connect relevant, local impacts to the less tangible, complex global issue of climate change.

Few studies have looked at framing or other key science communication concepts in the context of communicating about climate change adaptation (Moser, 2014). More and more research is calling for user-driven science, citing the divide between climate scientists and stakeholder groups (Kiem & Austin, 2013; Knapp & Trainor, 2013; Moss et al., 2013). At the same time, science communication literature is outlining methods to promote better communication, including—but not limited to audience research, effectively framing information, and working towards an engagement model of science communication. It's clear that communication research has a role in climate change adaptation and practice-relevant research, but the bridges between these bodies of literature are only beginning to be constructed.

CHAPTER 3
METHODS

3.1 Study Site

The goal of this study was to identify the environmental changes and risks, responses, and information needs of nature-based tour operators in Juneau, Alaska. Once dominated by logging and milling, the economy of southeast Alaska has shifted during the past several decades. In Juneau, the economy is currently dominated by fishing, tourism, and jobs in the government sector (Safford et al., 2012). Tourism supports 9% of all Alaska employment, but in terms of its impact to a regional economy, tourism employment is most significant in Southeast Alaska (McDowell Group, 2014). Tourism supports 21% of all jobs and 15% of all labor income in Southeast Alaska (McDowell Group, 2014). The city of Juneau and the surrounding borough have approximately 31,000 residents, but Juneau receives nearly 1 million out of state visitors each year (McDowell Group, 2012; Safford et al., 2013). Most of these visitors arrive via cruise ship, so local tourism demand is closely influenced by the decisions of major cruise ship companies. Some indicators suggest that tourism-related employment and income is slowly increasing as demand rebounds from the 2008 recession (McDowell Group, 2014).

Juneau is the capital of Alaska and the economic hub of Southeast Alaska. As one of the state's largest cities, it is distinguished by its lack of access to the road system. Travel to and from Juneau is limited to air and marine forms of transportation. Geographically, Juneau is well situated to host a wide range of nature-based tourism activities in a relatively small geographic area. Nearby flights to the icefield and glaciers take visitors beyond the city in a matter of minutes. Extensive trail systems bring tourists into the coastal temperate rainforest, to glaciers, and

to wildlife. Fishing charters and whale watching tours are offered throughout the summer season on Juneau's relatively calm, island-protected waters.

Juneau has developed an extensive physical and social infrastructure to support and regulate tourism activities. There is a deep-water port near the downtown area, and cruise ships are able to connect to the electric grid to take advantage of Juneau's clean hydropower. The Tourism Best Management Practices (TBMP) group sets standards for environmental and socially responsible business operations, and the Juneau Economic Development Corporation's cluster program matches local research capacity to community-identified environmental and economic research needs.

3.2 Study Participants

The unique geographic, social, and economic traits of Juneau make it a useful place to conduct research with nature-based tour operators. Juneau provides a concentration of many small and medium sized, locally owned businesses that offer a wide range of nature-based tourism activities, including charter fishing, whale watching, hiking, sightseeing, and much more. Using internet searches, visitor guides, and other lists found online, over 50 nature-based tour companies were identified in Juneau. There were probably several operators excluded from this list, either because they were not as well advertised or they work directly with booking companies to obtain customers rather than independent advertising. Furthermore, some operators may not have been included if their advertising materials did not suggest a significant reliance on the natural environment for their activities. The definition of nature based tourism lacks an objective measure of reliance on the natural environment, so the selections may be biased based on the investigator's subjective understanding of the definition.

The goal of this study was to produce context rich, locally useful results. Efforts were made to obtain a purposive sample that included operators with different positions in the organizations and different sized organizations that represented a variety of activities and resource uses. Because the contact information was collected through publicly available websites and visitor guides, the invitations to participate were often funneled through information request forms and administrative personnel. It was an ongoing challenge to get in contact with people to participate and this contributed to the small number of study participants. In general, the participants included in this study are a direct result of their organizations' and their own willingness to participate in the study, which may introduce further biases in the results. Operators disinterested in the study topic were probably less likely to return phone calls or emails to participate. The objective was to interview 30 individuals with each third representing employees at different levels of the organization (executive, mid-level, and staff), but the organizations asked to participate in the study generally identified the individual(s) that would be interviewed.

3.3 Questionnaire Design

Several previous survey tools have been developed to assess organizational awareness of and response to climate change (Archie, 2013; Archie et al., 2012; Finzi Hart et al., 2012). Like other tourism studies, the results of this study were expected to be highly context dependent. While some questions were borrowed from prior surveys, several original questions were developed to account for regional important subjects like glaciers, streams, and estuaries. Because little prior research has focused on tourism and climate in Alaska, a qualitative approach would also enable the collection of broad baseline data that could be used to construct more quantitative or experimental approaches in the future. The questionnaire (Appendix 3) consisted of both multiple choice and open-ended questions that represented four sections (Table 1) relating to

each research question: 1) perceptions of environmental change, 2) organizational response to environmental change, 3) information needs and communication processes, and 4) background information.

Table 1. Sample Questions.
A sample of questions that were asked during the interviews.

Section	Sample Questions
Environmental Change	Please describe the ways that environmental change, including climate change, impacts your organization. In the past, have you ever had to shift your business model to respond to changes in glaciers, streams, or estuaries? If yes, please describe. Climate projections suggest warmer weather and increased precipitation in Southeast Alaska. If these projections are correct, how would your organization respond to these changes?
Organization Response	Is your organization responding to climate change in Southeast Alaska? What are the specific ways your organization is responding to climate change? Could you describe any barriers or hurdles your organization has faced in responding to climate change?
Information and Communication	Has your organization ever been asked about the kind of information you would like about climate change in Southeast Alaska? By whom? Could you describe the characteristics of the information (i.e. length, delivery, format, etc.) that makes climate change information useful to your organization? How easy or difficult is it for you to find relevant information about climate change?
Background	Do you think that climate change is happening? How much do you think climate change will harm you personally? At which scale or area does your organization work? What types of activities does your organization offer? What is your position in the organization?

Study participants were asked to describe how environmental change, including climate change, impacted their organization. Participants were purposefully asked more generally about environmental change so that they described what they were observing more generally and not just what they had attributed to climate change. There is research to suggest that we take cues from the environment to reinforce what we believe about climate change (Myers, Maibach, Roser-Renouf, Akerlof, & Leiserowitz, 2013). If a participant doesn't believe that climate change is occurring, they could still be observing meaningful changes in the environment and even responding to those changes.

However, the problem in asking about environmental change is that unless participants explicitly described attributing a particular impact or taking a particular action due to climate change, there is no way of knowing whether the response was to climate change, another stressor, or some combination of both. It's well recognized that climate change adaptation is often the product of climatic and non-climatic stressors (Adger et al., 2005; Berrang-Ford et al., 2011), but teasing these various drivers apart in great detail was outside of the scope of this work.

The draft questionnaire was reviewed by several interdisciplinary social scientists, and the feedback was incorporated. After the review process, the questionnaire was piloted and discussed with five local experts from the fields of tourism and resource management in Juneau, Alaska. Participants were asked to respond to the questions, and following the interview the questionnaire timing, format, and questions was discussed more generally. The pilot interviews were either video or audio recorded, and the recordings were used to assess the quality of the questionnaire. The questionnaire was revised to increase the clarity of the questions and to reflect the comments of the pilot study participants. Participants of the pilot study also helped to identify the best timing for conducting the interviews.

3.4 Interviews

Most of the interviews were scheduled and conducted during a two-week period in late August to early September 2013. In an effort to obtain more study participants, six additional people were interviewed over the phone during November-December 2013. Relying on the advise of local experts, the interviews were scheduled towards the end of the peak tourism season in late August and September—when few cruise ships are in port and before operators take off for fall and winter vacations.

From the list of approximately 50 nature-based tourism operators, operators were contacted via telephone or email three to four weeks in advance. Several operators simply said that this was too far out to schedule, and to call them back when the interview period began. The day-to-day schedules of the operators varied based on the number of cruise ships in port and the weather, and so this impromptu scheduling worked and was preferred by the respondents. As interviews were scheduled and completed, attention was devoted to ensuring that a diverse set of organizations was included in the study. If potential study participants were unable to be reached after three calls or emails, they were dropped from the list of potential study participants.

The interviews ranged from 20 to 40 minutes and were most often conducted in the participants' place of work or another agreed upon location. Before the interview began, a brief description of the study was provided, the confidentiality of the participant and their business was explained, and participant signed the consent to participate form (Appendix 2). While there was a printed list of the questions available during the interviews, the interviews were semi structured—with all the planned questions being asked, but reordered if it helped the flow of the conversation. Because of the interest in really context specific results, participants were given the

latitude to discuss whatever came to mind as the interview progressed.

Seventeen of the 24 interviews were recorded using an iPhone recorder application. Interviews were not recorded when participants did not wish to be recorded and when the research partner was unable to record the interviews. When interviews were not recorded, written notes were taken on the printed questionnaire. The recordings were transcribed and the written responses were typed, so that all of the responses could be coded and analyzed. The recordings and other data are securely stored with numeric identifiers and without names. The Institutional Review Board approval for this study came under application 423231-3 (Appendix 1).

3.5 Analysis

Participant responses to the multiple-choice questions were entered into Microsoft Excel and analyzed using descriptive statistics. The responses from the 15-question version of the Global Warming's Six Americas survey tool were entered into IBM SPSS Statistics Version 21 where they were analyzed using code provided with the survey instrument (Maibach et al., 2011a). The interview transcripts, the Six Americas classifications, and the demographic data for the study participants and the organizations were imported into NVivo, a qualitative analysis program. The qualitative codes and themes were not predetermined, so the interview transcripts were initially coded to identify the emergent themes. After this initial coding effort, a coding guide was developed. The coding guide has major themes and definitions for each of the main research questions: environmental change, organization response, and communication and information (Appendix 4). Using the coding guide, the interview transcripts were reviewed twice more to make sure that any relevant statements were coded and accounted for. The frequencies of specific codes were analyzed in conjunction with the individuals and organization demographic

and background information.

CHAPTER 4
RESULTS

4.1 Participant Background Information

Twenty-four individuals representing 20 different businesses participated in the study. In general, organizations asked to participate in the study put forth their senior or mid-level managers—who were generally older with more time in their area of expertise—to participate in the study. Most of the participants (55%) worked in the executive level of the organization, followed by 33% of participants at mid-level, and just 12% who described themselves as staff or other. Participants ranged in age from 23 to 74, with an average age of 49. Eighty-three percent of the participants were male and 16% were female. Almost all (92%) of the participants described themselves as Alaska residents. Over 50% of the participants have spent more than 15 years working in their area of expertise. Thirty-three percent had spent 5 to 15 years in their area of expertise, and 13% had been in their area of expertise for less than five years.

Study participants have a much higher awareness and concern about climate change than the American public as a whole (Figure 7). Seventy percent of participants were either "alarmed" or "concerned" about climate change using the Global Warming's Six Americas tool. Only four participants fell into the "disengaged", "doubtful", and "dismissive" sectors of the population. Being that the study was about environmental change and this was made clear to the participants in the invitation, the participants may be biased towards greater levels of issue concern because individuals with lower levels of issue engagement may have chosen to not participate in the study for that reason.

The organizations themselves varied widely. A majority of the organizations (54%) oper-

ated at the scale of Southeast Alaska. An additional 25% operated at the Juneau community level, and the remainder worked at the statewide or beyond statewide scale. The organizations that were represented in the study have been established anywhere between 8-65 years. The organizations had anywhere from one to 80 full time employees. While conducting the interviews, it was apparent that many of the organizations interviewed offered more than one type of activity, and sometimes these were similar like fishing and fishing booking while other companies conducted both hiking tours and whale watching tours. As a result, more organization activity types are recorded than total organizations (Figure 8).

4.2 Nature-Based Tour Operators' Perceptions of Environmental Change

4.2.1 Weather and Climate

Only 16% of the study participants believed that changes in the environment did not affect their operations. The majority of study participants, however, believed that changes in the environment did affect their operations—primarily through changes in weather and climate. Almost half (45%) of the study participants talked about the negative impacts of cold, rainy, and foggy weather on their operations. Study participants described how cold, rainy, and foggy conditions could cause clients to drop out of reservations or choose other activities, made access to resources more challenging or impossible, and sometimes caused tour activities to be cancelled. Several participants talked about the devastatingly cold, wet, and foggy summer of 2012. One study participant described how they had a 40% cancellation rate during the summer of 2012 due to foggy, unflyable conditions, and they went on to add that a few seasons like that in a row could put them out of business. Other study participants echoed similar concerns—that the success of their business is dictated by weather and the ability to conduct their activities in those conditions.

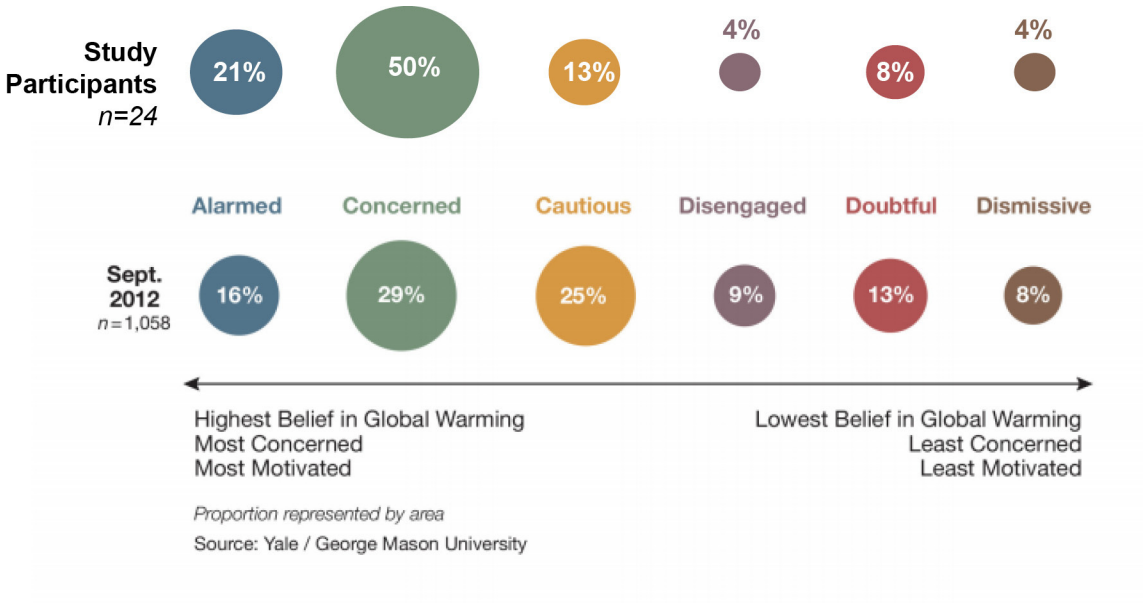


Figure 7. Study Participants in Climate Change/Global Warming's Six Americas.

A greater percentage of study participants are in the Alarmed and Concerned groups of the Global Warming's Six Americas segments than the American public in 2012. It should be noted that the study participants were not a random sample (*n*=24, represented 20 of 50 known nature-based tour operations).

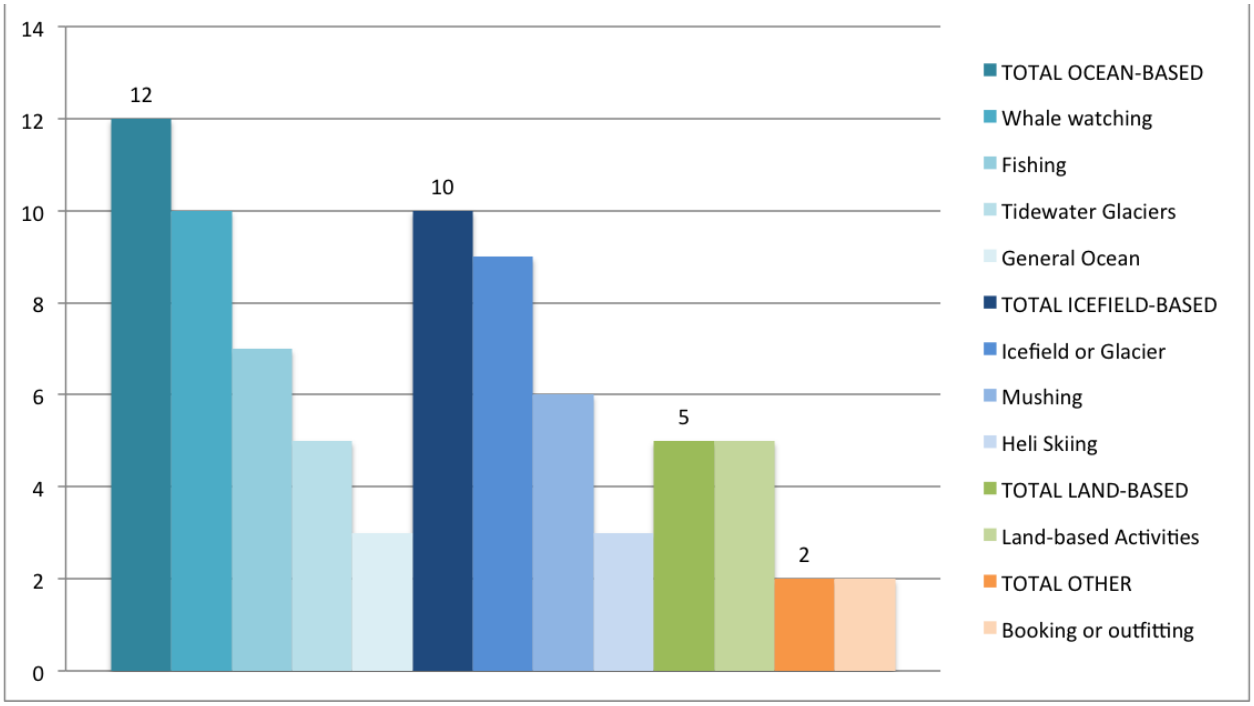


Figure 8. Types of Activities Offered by Study Participants.

Study participants' organizations conducted commercial tour activities on the ocean, icefield, and the lands surrounding Juneau. An additional two organizations provided booking and outfitting services.

Fewer people (20%) talked about the opportunities that would be presented if Juneau's weather were warmer and dryer. Sunny, warm weather was experienced during the summer of 2013, and study participants generally perceived that it was good for business. One participant described how, "the passengers are going to go back after this summer…praising Alaska's great weather." They added that, "the better experience people have up here when they are visiting, the better chance it will influence someone's decision to come here." When talking about the effects of weather on their operations, some participants contrasted the summers of 2012 and 2013. One participant explained how, "two years ago [2012] we had the wettest summer on record and the people were really grumpy, and the past summer [2013] the sun shown and the people were really nice!"

Mark Twain once said, "everybody talks about the weather, but nobody does anything about it." Even though participants described both risks and opportunities associated with the weather, many (37%) study participants expressed indifference about changes in weather. Some participants described the extreme year-to year and day-to-day variability of Juneau's weather and how they couldn't conceive changes so far outside this variability that they wouldn't be able to respond. Resonating this theme, one participant described how, " [the] weather plays a part in every single day we have. A [future] change in the weather will be just like a change in the weather from one day to the next." Other operators described how they already have rules in place to deal with weather, and that changes in weather aren't going to change the rules that enable them to travel or conduct their tours under certain conditions.

When talking about climate and weather, several participants (16%) were hesitant to connect any changes they had observed to climate change or global warming. These participants generally felt that the Earth's history was long compared to what they had experienced and that

the connections between climate change and any given factor—such as wind, precipitation, and river freeze up—were too uncertain. One participant described how they are, "always careful to blame things on climate change, because it could be so many other little factors that have nothing to do with change." While these factors did not emerge as major themes, a few study participants also talked about how wind and the dates of freeze up and thaw were important factors for their operations.

4.2.2 A Shared Concern: Glaciers

Most of the study participants (70%) acknowledged that nearby glaciers are retreating and shrinking in size and that if glaciers disappeared there would be negative consequences for their businesses and the local tourism industry. Many study participants described how important glaciers are to Alaska and Juneau as a tourist destination. For example, one participant described how, "it's the top of the ticket of what you want to see when you come to Alaska—it's Glacier Bay—and if glaciers were all to recede or cease to exist…that changes how Alaska markets itself." Another study participant described how their sales of a particular tour doubled when it included a glacier. A couple of operators noted how more people may be motivated to visit Alaska or would be willing to pay more to see glaciers as people continue to perceive that they are disappearing. This was perceived as an opportunity of glacier loss—albeit a short-term one.

Most study participants believed that the impacts of glacier loss would be negative. The negative impacts ranged from not being able to see and easily access the Mendenhall Glacier, not having a glacier to guide on, no longer being able to safely operate on glaciers, and being forced to travel further to access glaciers. Other operators described how changes in glaciers could impact hydrology, change salmon habitat, contribute to sea level rise, and affect oceanographic

conditions.

While glacier change could spell severe impacts, nearly 30% of the study participants postulate that the changes in glaciers will have little impact during their lifetime or the life of their business. Illustrative of this point, one participant described how, "[the glaciers] are definitely shrinking faster than they have been over the last 30, 40, 50 years, but there is still a lot of glacier out there." Another participant described that their helicopters might, "have to fly a little farther in 10 or 15 years—but I don't see any short term impacts to us." Many participants believed that there is a lot of glacier still out there, and the rate of change is slow enough to respond to. Significant changes—like whole glaciers disappearing—were perceived as major—yet far off—risks. A couple of operators, however, described how the risk of glacier change was more imminent and in one case, is already affecting their operation.

4.2.3 Environmental Concerns by Sector

While changes in the weather and glaciers were more universally discussed among study participants, nature-based tourism operators also described specific concerns that were unique to the place and method of accessing their resources. These groups were not predetermined, but rather emerged from the qualitative analysis as major environmental concerns were coded.

4.2.3.1 Land-Based Operators

The smallest subgroup interviewed in this study, land-based operators (n= 5), or those companies that offer hiking, biking, sightseeing, stream fishing, or other land-based tours (not including the icefield) were most concerned about how environmental change would affect resource access and permitting. Access can be challenging for some of these operators, because they are relying on human-powered, generally slower modes of transportation. Cruise ship pas-

sengers, however, often have strict time constraints for their activities. One study participant talked about how their tour takes longer as the Mendenhall Glacier retreats, but described how they're, "getting creative to think about ways to…do the trip differently." Another study participant described how a very large rock blocks part of the view of the Mendenhall Glacier, and believes that "in 5-10 years…the glacier will have pulled back behind that rock…[and] that trail will be virtually closed to us." For land-based operators, the effects of glacier change—specifically at the Mendenhall Glacier—are already being felt.

Study participants described how responding to these changes means negotiating new commercial operator permits with the U.S. Forest Service—the primary landholder in the area. The permits outline the days of the week, times, group sizes, and places where a specific businesses can operate. One study participant described how within the decade they'll probably want to use different trails so they can continue to visit a glacier during their hiking tour, but they realize that obtaining new commercial use permits and competing with the demands of locals and other operators could make future access to the glacier more challenging.

4.2.3.2 Ocean-Based Operators

Ocean based operators (n=12) included businesses that offered whale watching, sport fishing, tidewater glacier viewing, boat charters, or other ocean-based activities. Ocean-based operators were most concerned about changes in salmon populations and crowding during whale watching tours. Like glaciers, several study participants noted that salmon and sport fishing are important resources and activities that impact tourist demand. Whale watching is a growing activity in the region, and one participant described that Juneau's popularity for whale watching comes from the dependable nature of seeing whales and several whale watching tours guarantee

whale sightings during their trips.

Unlike changes in glaciers that were perceived with more certainty, study participants expressed a lot of uncertainty about the future of salmon populations and their vulnerability to changes in temperature, rainfall, glaciers, overfishing, and pollution. Uncertainty may come from the high amounts of existing variability in salmon returns from year to year. For example, one study participant explained how, "living in Alaska…you know, some years have more fish, some years have less fish…the water temperatures are a little colder one spring or warmer one spring, or different runs come back that are more abundant than other times, and you know it could be the freshwater, rain water, colder spring temperatures." Like this participant, another also described the complex interactions in the system that supports salmon, "In theory if all the glaciers were to melt today, and ocean levels rose, it would severely affect things. You're going to have some streams that will be gone, more fresh water. It will definitely affect salmon runs—so that would totally change our life."

Ocean-based operators expressed concerns about whether climate change could affect the dependability of the whale populations, and had theories about warmer water driving them northward or leading to declines in krill and herring populations that would drive the whales to new locations. The primary concern among ocean-based operators related to whales, however, was overcrowding. Participants described how in the past several years the number of whale watching tours has increased rapidly. One participant described how, "you have a pod of whales, and because a plethora of guides are doing it, that [pod] has 20 boats around it. What does that do? I mean we don't know."

Ocean-based operators had several other less frequently mentioned concerns about

environmental change. One participant described the risk of repeated weak salmon runs, and word getting out among prospective tourists about how fishing was not good. A few ocean-based operators knew little about the impacts on salmon, but mentioned ocean acidification. Boats that utilize Glacier Bay or Tracy Arm also talked about the problems related to increasing iceberg concentration or the loss of tidewater glaciers. One participant described how, "Glacier Bay's Lamplaugh Glacier—[it's] beached and not calving, so we're not visiting it anymore." A couple operators also described how increasing numbers of icebergs in some areas was making travel more difficult.

4.2.3.3 Icefield-Based Operators

Icefield-based operators (*n*=10) include those businesses that offer activities on the glaciers or icefield, such as trekking, dog mushing, or transportation to the icefield or glaciers. Changes in glaciers were among the primary concerns of icefield-based operators, but other important environmental factors were snow, fog, and the general challenges of working in this extreme environment. In regards to glacier change, one study participant described how, "we operate…on a dying glacier, its not being fed anymore—so that glacier is going to die, it's going to go away, we have known about it for awhile. We can't stop that...so yes, we're concerned. We're actively pursuing alternative measures." As noted earlier, however, the risk of glacier recession or loss is viewed as a relatively distant threat for most of the operators who were interviewed.

A more urgent concern among the icefield-based operators is snowfall. The snow that falls on the glaciers and icefield during the winter months melts throughout the summer. As it melts, the transient snow line, a line separating snow from hard, blue glacier ice moves up the glacier to higher elevations. The location of this line is important to icefield-based operators,

because many want to operate above the snow line and need sufficient amounts of snow to safely run their tours. The location of the snowline depends on the amount of snowfall in the winter and the summer temperatures. As one participant describes,

> "higher snow cover—obviously its better for us. Like this year [2013] is a prime example. We are operating on last years [2012] snow at this point. The glacier… hasn't even lost its snow because two years ago there was so much snow…When do we get it? Is it rain? Or is it snow? If it's snow it's a good thing, and if it's rain it's a bad thing."

Echoing this point, another study participant described how they had to leave the glacier earlier than they had planned two out of the past seven seasons because they ran out of snow. They were skeptical whether these changes could be attributed to climate change, and go on to describe that, "it's so localized…The guys sitting on Norris Glacier had to abandon ship last week because they ran out of snow, while we are having excellent snow cover."

The prevalence and elevation of fog was another environmental concern among ice-field- based operators. One participant described how, "Increased precipitation doesn't affect our product as much as clouds. If it's raining at 5000 or 6000 feet, I conduct business. If the clouds and dew point drop down to less than 1500 feet, I don't fly. So it isn't the heaviness of the rain—it's the heaviness of the clouds." Another icefield-based operator added that, "when it all comes down to it, if we can't fly enough people—if the weather gets to a point where there are so many days we can't fly—once you're not making money—it doesn't work anymore. That's really our biggest challenge I guess…its accessibility."

In addition to the snow and fog, many of the icefield-based operators described that

responding to slight changes in the glacier is an ongoing challenge. For example, many of the operations start at a lower camp and move to a higher camp midsummer to stay above the snowline. Those businesses operating on the blue ice, below the snowline, are constantly looking for interesting features to take guests to see. One participant illustrated this issue by describing how, "finding areas to operate our tours…[has] been a problem since day one for 15 years. The glacier changes so much. We just notice a lot of changes as the glacier has shrank." They added that from their main trekking site, "line of sight to the facility has gotten worse, so radio communications have been harder."

4.2.4 Interacting Factors

Several of the study participants described system interactions or institutional arrangements that compound the impacts of any given change in the environment. For example, the price of fuel is an important concern among those operators using motorized means, such as boats or helicopters, to access resources. Especially for helicopter operations whose primary resource—glaciers—may be moving further away, there is a balancing act. In response to the questions about the point at which changes in glaciers would impact your business, one participant responded, "at the point at which we went over the tipping point of if it's worth it for us to fly that far—what we are charging is appropriate for what we have to spend. There is a price point. That depends too on how expensive fuel is…that balancing act." Similarly, a fishing guide was concerned that the combination of poor salmon runs and bad weather cause people to leave the sport, which negatively impacts their business. The study participant hypothesized that guests can only take so much bad weather if they aren't catching fish, and he went on to describe that, "weather and poor salmon runs, the two are like the nail in the coffin for us." This particular participant also described how they have watched the decline of some similar businesses in the

Matanuska-Susitna Valley, citing how quickly potential visitors learn about the repeated years of poor salmon runs and that definitely impacts demand.

4.3 Nature-Based Tour Operators' Response to Environmental Change

4.3.1 Adaptation, Mitigation, and Conservation

Unlike the more generally worded interview questions about perceptions of environmental change, the questionnaire asked specifically about nature-based tour operators response to climate change. Despite this, the interview questions tended to be interpreted more broadly. The study participants described a wide range of responses to climate, environmental, and social changes that could be classified as climate change adaptation or mitigation activities or more general conservation and environmental stewardship activities. A quarter (25%) of the study participants described responding to climate change with what could be considered conservation or climate change mitigation activities, such as conserving fuel or recycling. One participant described how their response to climate change is, "more about adapting the way we do business to manage our impact—minimizing the number of flights we take—it works better [than]… looking at what we need to change in the next 15-20 years." Another participant described how their company didn't talk about climate change adaptation, but rather they, "discuss it in terms of being environmentally friendly."

4.3.2 No Response

About a third (29%) of the study participants said that they were not doing anything to respond to climate change. The reasons for not responding ranged from not seeing anything they needed to respond to, to feeling like there is nothing that can be done, to explicitly describing that they don't care about climate change. Most frequently, participants described not seeing

anything to respond to. As one participant stated, right now they are, "thinking about it [climate change]. Responding—right now—its not needed." Two study participants believed that environmental changes could impact their operations, but didn't think there was anything they could do about it. Two more felt that environmental changes didn't impact their operations, but even if they did, there is nothing that can be done.

4.3.3 Coping with Environmental Change

Another third (37%) of study participants described the ways they were coping with changes in the environment—regardless of whether they could be attributed to climate or not. Coping strategies tended to be activities that generally expanded or intensified existing risk management activities. Depending on the business type, the coping responses varied widely. Most often, study participants described changing the location of their operations to maintain a desired condition (i.e. amount of snow, safety of glacier), changing the trip style to avoid risks (i.e. rerouting tours, changing itineraries), or investing time and money differently (i.e. spending more time searching for fish, buying more beverages). Some of these activities, such as moving to higher elevations on the icefield with greater snow cover, have been happening for years and have become part of the typical business practice for icefield based operators. Other responses were more immediate and tended to be closely related to the specific weather conditions on a given day. Expounding on this approach, one participant described, "[climate change] hasn't really been a topic for us at this point…I mean we kind of respond to the here and now…during the summer."

4.3.4 Planned Climate Change Adaptation

Very few (n=4) of the study participants described participating in planned climate

change adaptation activities, and the few who were could probably be categorized into the "understanding" phase of Moser and Ekstrom's (2010) adaptation process model. Many of these participants could be described as gathering more information and trying to better understand how climate change would impact their businesses. One study participant described how their company had assembled a task force to gather more information to bring back to the executive level of the organization. While tourism operators were not creating any written adaptation plans, a couple of study participants had included climate change in their business or other long-range plans. Some operators also described creating new businesses, diversifying, or finding new locations to operate. One icefield operator described how, "We've been looking at new locations, new activities, new products for awhile…In Alaska people just see it, you see stuff going on, you have to be aware of it."

While most study participants were not actively planning for climate change, half of the study participants described beginning to talk about climate change with their colleagues. One participant described how, "my colleagues and I have occasionally talked about it…[we] have some ideas and hypothesis." A few study participants had engaged in more strategic conversations about the impacts with colleagues and outside agencies, such as the U. S. Forest Service. One participant described how they have meetings with the U. S. Forest Service to, "review glaciers and locations…on an annual basis to discuss those things and stay ahead of it," noting how, "it all gets back to our product—we land on glaciers."

4.3.5 Barriers to Responding

Like other interview questions, the questions about barriers were also interpreted more broadly, and participants described barriers to climate change and other interacting factors. Study

participants described that institutional rules, money and personnel resources, and information were barriers to adapting to climate change and participating in mitigation and conservation activities more generally. A quarter of study participants described that institutional rules and challenges with the permitting process hindered their ability to respond to environmental changes as readily and quickly as they would like. One participant described how, "the biggest thing [barrier] for us would be if we were to change the way we operate and where we operate, it would be an application to the Forest Service to move locations."

Another quarter of participants described that a lack of money and staff resources was a barrier. Most often, these comments were made in regards to the time needed to review information and the costs of conservation activities, such as participating in recycling or changing the existing infrastructure. For example, one participant described how their company spends $1000 a day on recycling—but they felt like it was important to make an effort. Another participant described how, "it's a good idea to try to be friendly about the environment, but you still have to make money. You still have to survive. You have to be able to pay the bills." One participant made an interesting point about how they were too small to develop a response at the company level and envisioned that the leadership on climate change would more likely be at a community level. This individual said, "I think it's more realistic that we'll be participating in a program that addresses it at a tourism companies level, which tends to be the way things are done here in Juneau—it's kind of more at the community level."

Information and communication related barriers came up a few times in the interviews. Participants described not being able to find information about climate change in Southeast Alaska and how the facts were confusing. One participant described how, "I am quite confused of what is and what is not…Taku Glacier is advancing, Mendenhall Glacier is receding. [Scientists]

are supposed to be 1000 times smarter than me and you got me more confused!" Twenty percent of participants did not feel like there were any barriers to responding. Other less frequently described barriers included limited technology for addressing environmental problems, conflicting internal interests of the company, public ignorance, and everyday variability in the weather.

4.3.6 Opportunities

Although participants were asked specifically, they did not tend to identify specific climate change-related opportunities for their businesses. Many of the study participants did, however, describe their ability to adapt to whatever happens. A quarter of the study participants described how they are constantly adapting and responding to changing conditions, and how adaptation "just happens" in the tourism industry. One participant described how, "the most beautiful thing about tourism is that no matter what the change—if we can control it or if we can't—we always adapt, always, we just do…we've never cancelled a tour, we just have to do it!" Another study participant described how, "It would take some huge devastation to really shut us down… just adapting and adjusting to whatever dynamic weather pattern gets thrown at us, that's just what we have to do." Several participants also added that they are always looking for opportunities. As one individual noted, "we always look for opportunities…what will people need to continue to catch fish?"

4.4 Nature-Based Tour Operators' Climate Change Information Needs

4.4.1 Information and Communication-Related Barriers

The study participants identified several barriers that inhibited their response to climate change, but information and communication-related barriers occurred infrequently in the qualitative analysis. In addition to the qualitative analysis, several multiple-choice questions were

included in the questionnaire to specifically identify the prevalence of some previously identified information and communication-related barriers to climate change adaptation. Previously identified information and communication-related barriers include problem detection; receptivity, willingness, and ability to use climate change information; availability and accessibility of climate change information; salience and relevance of climate change information; trust in the sources; and legitimacy of the process used to generate information (Cash et al., 2003; Ekstrom, Moser, & Torn, 2011; National Research Council, 2010).

4.4.1.1 Problem Detection

Problem detection is not always included as an information-related barrier to climate change adaptation; however, detecting a problem is one factor that leads towards information-finding behaviors (Moser & Ekstrom, 2012; Reser & Swim, 2011). Participants were given the 15-question version of the Global Warming's Six Americas survey to identify attitudes related to climate change (Maibach, Leiserowitz, Roser-Renouf, Mertz, & Akerlof, 2011a). The results of these questions indicate that a majority of the study participants (56%) are extremely sure that climate change is happening, and another 29% of participants are very sure that it is happening. Although study participants were more likely to be in the "Alarmed" or "Concerned" segments of the population than the American public, most of the study participants believe that climate change is more greatly affecting people in other places and more likely to affect people in the future. Sixty percent of the study participants think that people in the United States are already being harmed by climate change, but only 12% of study participants believe that climate change will harm them "a great deal." Most participants (41%) think climate change will harm them only a moderate amount. Fifty percent of participants think that future generations of people will be harmed "a great deal" by climate change.

Even though an overwhelming majority of participants believe that climate change is occurring and that people in the United States are being harmed by it, many participants did not attribute their observations of environmental change to climate change. Changes in glaciers were commonly attributed to climate change, but in general participants described the impacts with a lot of uncertainty. When participants discussed the impacts of climate change, it was often described as what might happen in the future and as a risk that would become relevant after their lifetime or the life of their business. For example, one participant described how the big impact for them would be glacier recession, and described how "at some point it will be untenable for us to provide glacier tours…but that's probably pretty far in the future." A few participants described how the environmental changes they were seeing were not attributed to climate change. For example, one participant described how, "The glacier going back doesn't make any difference. That's a natural phenomenon that they're trying to call global warming."

4.4.1.2 Receptivity and Willingness to Use Information

Willingness to use information about climate change does not appear to be a meaningful barrier to climate change adaptation among the study participants. There was actually overwhelming agreement among study participants that their organizations' are willing to use climate change information (Figure 9). Well over half (70%) of the participants agreed that their organization would like to learn more about climate change, and about 50% of the study participants felt that their organizations agreed about the kind of climate change information they needed (Figure 9). The participants were often pleasantly surprised that someone was asking them what kind of information they wanted during the interviews and several expressed interest in learning about the results of this study and about other physical and biological research taking place in the region.

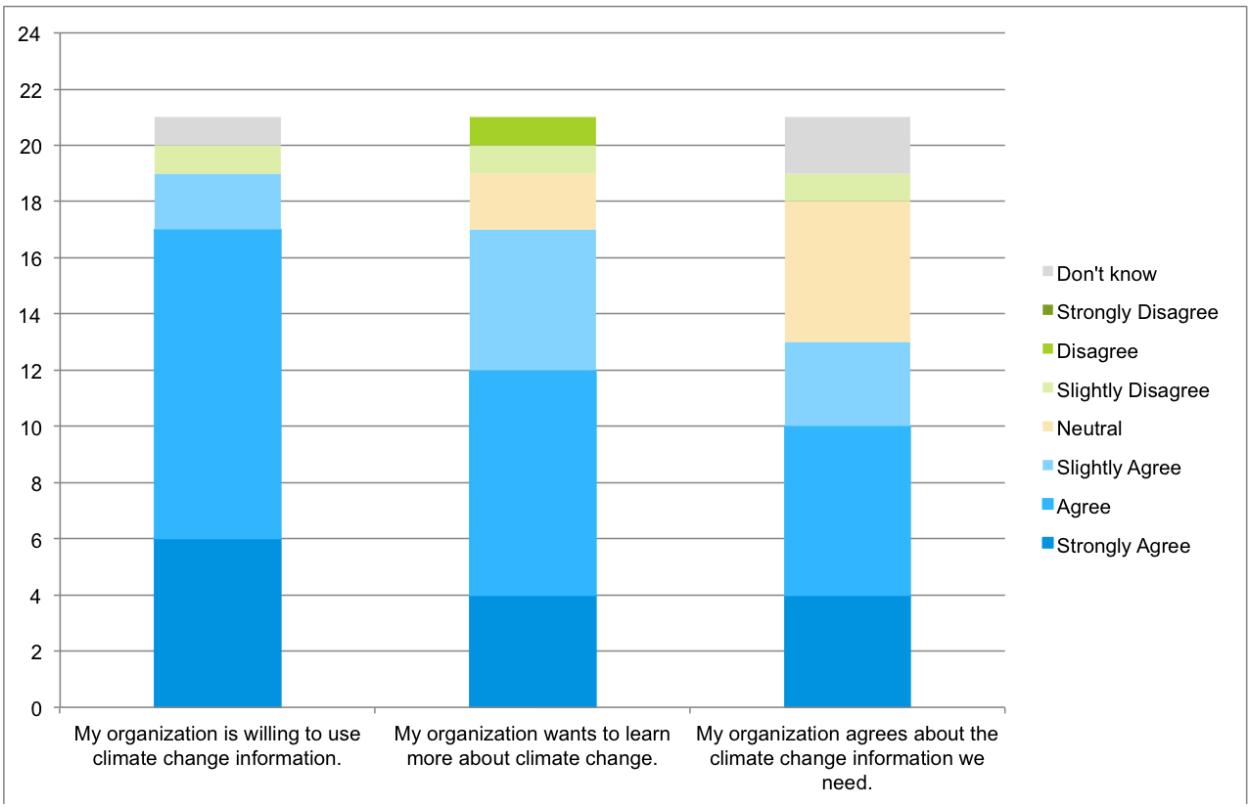


Figure 9. Receptivity and Willingness to Use Climate Change Information.

The majority of participants agreed that they were willing to use climate change information and that their organization was willing to learn more about climate change. There was less agreement about the climate change information organizations needed.

If there was any apprehension about using climate change information within their organization, the comments often reflected the perception that the information they wanted, with an appropriate level of certainty, did not exist. One participant described their reluctance to use climate change information:

> "I guess if we thought that somebody had good solid information that says, next year you are going to have 78 days of wind that will prevent you from flying or… you are going to have 37 days of fog that are not going to allow you to whale watch or fish, or if there was some sort of accurate predictor that said there was going to be half as many whales in Southeast Alaska…I guess it depends on the

> accuracy. Nobody can see the future. It's hard for me to put a lot of time and effort into something that may or may not happen. We're all about being prepared and making good business decisions based on what you think might happen, but you just never know…I just don't know that we would put a lot of resources into that."

There was some disagreement within organizations about the type of climate change information that is needed. This may be a reflection of the people who were interviewed and the fact that they represented different levels of the organization. For example, those middle management and staff people who we interviewed talked about needing weather information and information about climate change to give to visitors. Study participants at the executive level, however, indicated seeking information from local resource management agencies. The numbers of participants and comments make these inferences weak but may be reflecting some of the inter-organization conflict about what kind of information is needed.

4.4.1.3 Availability and Accessibility of Information

Sixty six percent of the study participants agreed that information about climate change information is easy to find and is easy to understand (Figure 10). Study participants often described that it was most easy to find the information on the internet or using a Google search. One participant described how they, "don't think it's hard to find [climate change] information. It's a matter of going out and finding the information when I want it." Another participant added, "If you know the right keywords you can find exactly what you want to find." Beyond accessing information on the internet, study participants described several local places where they access climate change information, including local scientists and naturalists and agencies, such as the

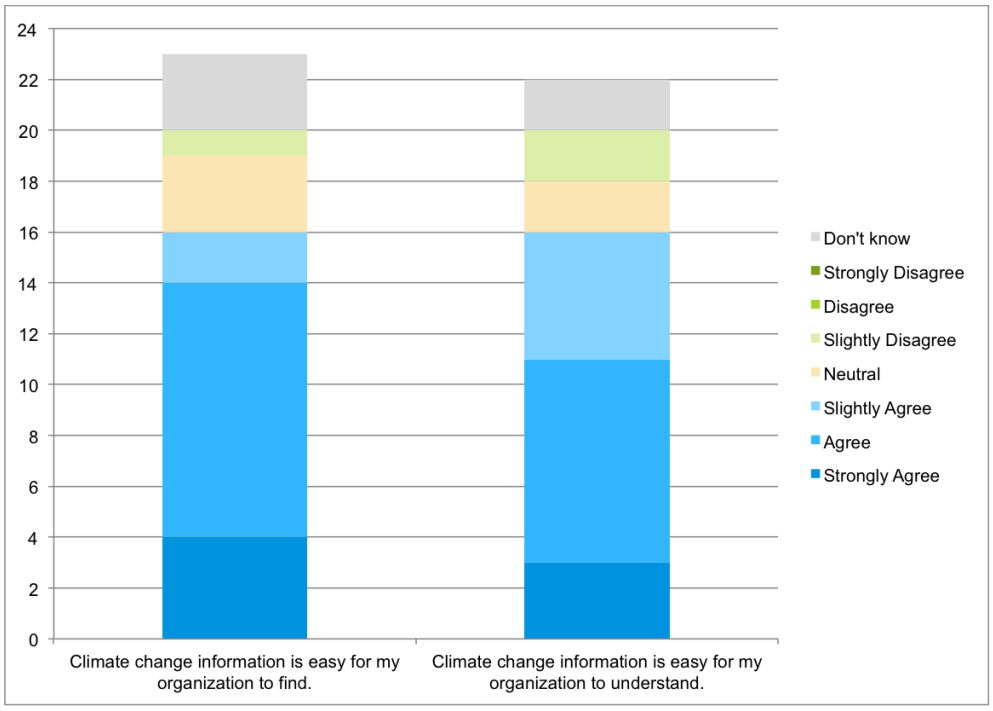


Figure 10. Availability and Accessibility of Information.
A majority of participants agreed that climate change information was easy for them to find and easy for their organizations to understand.

U.S. Forest Service and National Oceanic and Atmospheric Administration (NOAA).

While the majority of study participants described that it was easy to find information about climate change, nearly a third (29%) described some challenges with the availability and accessibility of climate change information. Many of these participants described that finding the information isn't that hard, but that it was challenging to find the specific types of climate change information they wanted. One participant described how finding this information is, "a little difficult for Alaska and Southeast [Alaska]", and another added that it was a, "little difficult for my industry, but not too bad."

Participants were also asked where they go for information for their work and how frequently they utilize particular sources (Figure 11). Study participants most frequently relied on weather forecasts, colleagues in their organization, and the internet. Study participants hardly

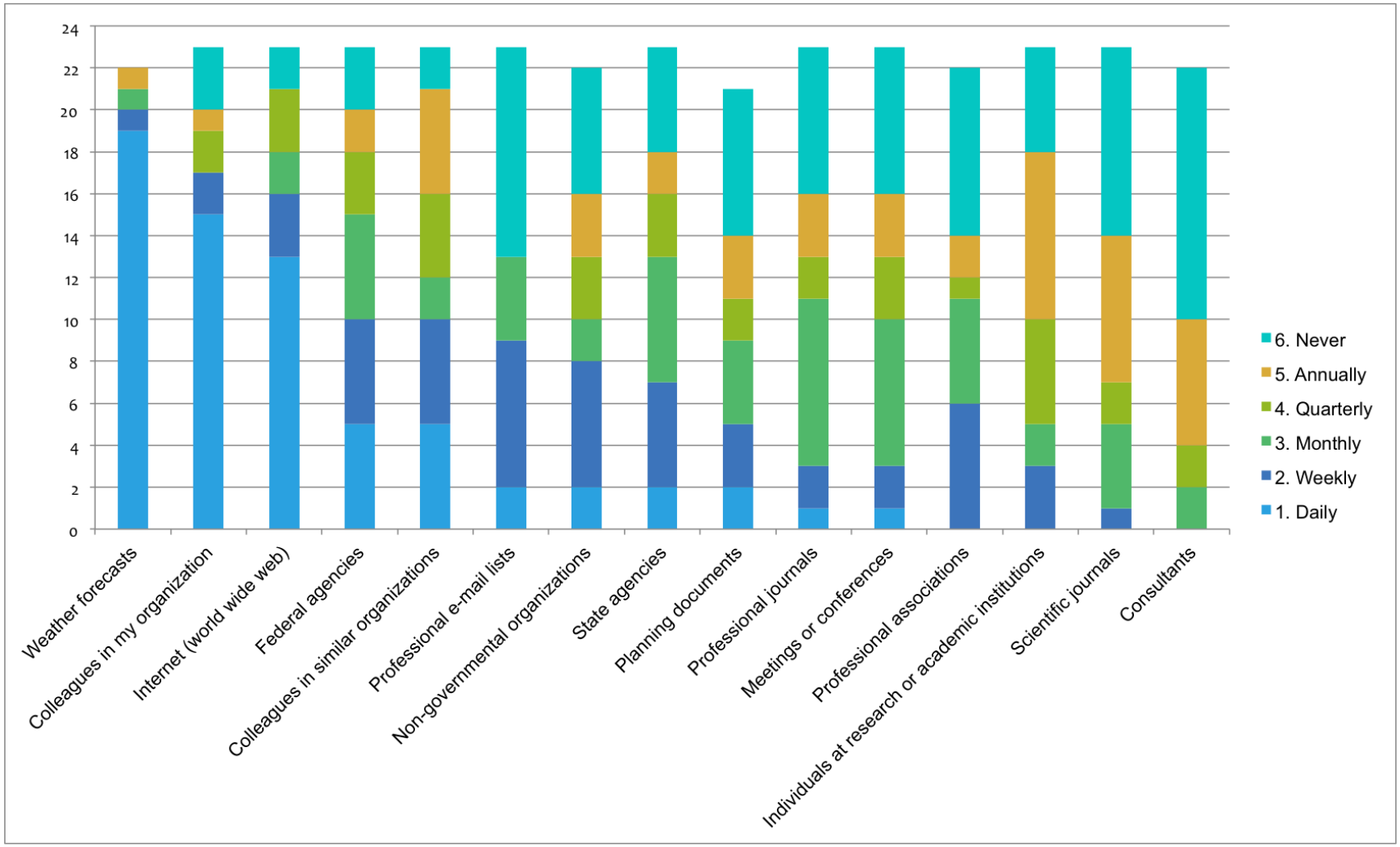


Figure 11. Information Sources.

Study participants primarily rely on weather forecasts, colleagues in their organization, and the internet for carrying out day to day activities. Other frequently used sources of information include federal agencies, similar organizations, professional email lists, NGOs, and state agencies. Notably, many participants described that they never use scientific journals.

ever used consultants or scientific journals for their work. There is an indication that some information sources are more important at different times of the year. For example, professional journals and meetings or conferences appear to be most frequently used on a monthly basis. Comments from participants also indicated that the annual timing of information is important, and seasonal information can be useful in the spring when they are planning for the upcoming season.

4.4.1.4 Salience and Relevance of Information

Study participants generally agreed that their organizations were willing to use climate change information and that the information was easy to find, but it is apparent that climate change information is not always relevant to their specific needs. Half of the participants agreed that they have been able to find concrete examples of the ways climate change may affect their organization and that they have been able to find answers to their questions about climate change, but only one participant strongly agreed with the latter point (Figure 12). As one participant described, "[climate change information is] fairly easy [to find], but I'm not sure how to assimilate it."

There may be a perception among participants that climate change information is easy to find because the subject is so salient, but there are some indications that local, specific climate change information needs are not being met. Despite thinking that information was easy to find, participants had a lot of questions about climate change and local resources (Table 2). For example, one participant explained how they, "need information about whale populations, glaciers, and the southeast fisheries." Another participant mentioned, "I don't know if there are any studies being done or answers, but one thing I heard about is ocean temperature and salinity. [These

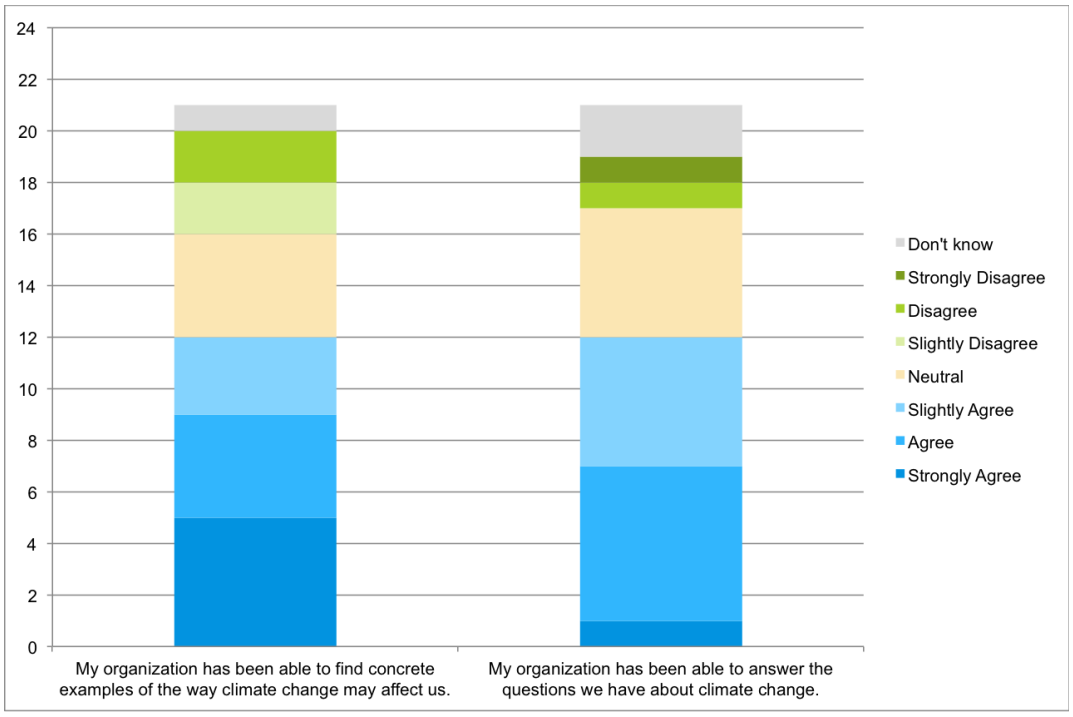


Figure 12. Salience and Relevance of Climate Change Information.

About half of participants agreed that their organizations have been able to find concrete examples about the impacts of climate change and that their organization's questions had been answered.

are] questions that come to mind because water is important around here."

Most of the questions that participants have about climate change were specific to Southeast Alaska and the community of Juneau. One participant asked, "What is the scientific answer to what will occur in Southeast in the next 10-15 years?" Spatially, climate change information might be most relevant to nature-based tourism operators if it focused primarily on Southeast Alaska and the Juneau community.

Table 2. Questions About Climate Change.

During the course of the interviews, study participants often raised questions about how particular resources would be impacted by climate change. This is a sample of questions that came up, organized by theme.

Theme	Common Questions
Ocean and Fisheries	Are warmer winters and more water good for salmon? How likely is ocean acidification and where is the tipping point? How will concentrated precipitation events impact salmon? What's happening with the herring population? Is ocean salinity changing? Are ocean temperatures changing, and how will that affect salmon? Is there an accurate way to predict the number of whales? How will climate change affect salmon? Will fish go deeper, shallower, etc.? Is sea level rising? Will there be substantial changes in fish runs?
Snow and Ice	How do receding glaciers affect streams, rivers, and estuaries? How are snow levels changing? Why are some glaciers advancing? What's happening with the Mendenhall Glacier?
Weather	What will average temperatures be in 10 years? Are there ways to project the number of days of wind/fog? Is the weather going to change or are we just losing the glacier?
General Climate Change	How much certainty is there in this data? Will wildlife move? Is it Industrial Revolution based? Nobody knows exactly what will happen, right?

This was confirmed in the participants' assessment of the utility of climate change information at given spatial scales (Figure 13). Almost all of the participants (91%) noted that information within 50 miles of Juneau and in all of Southeast Alaska would be very, moderately, or slightly useful. Participants envisioned slightly less utility for climate change information for all of Alaska, and only 50% of participants found climate change information about all of the United

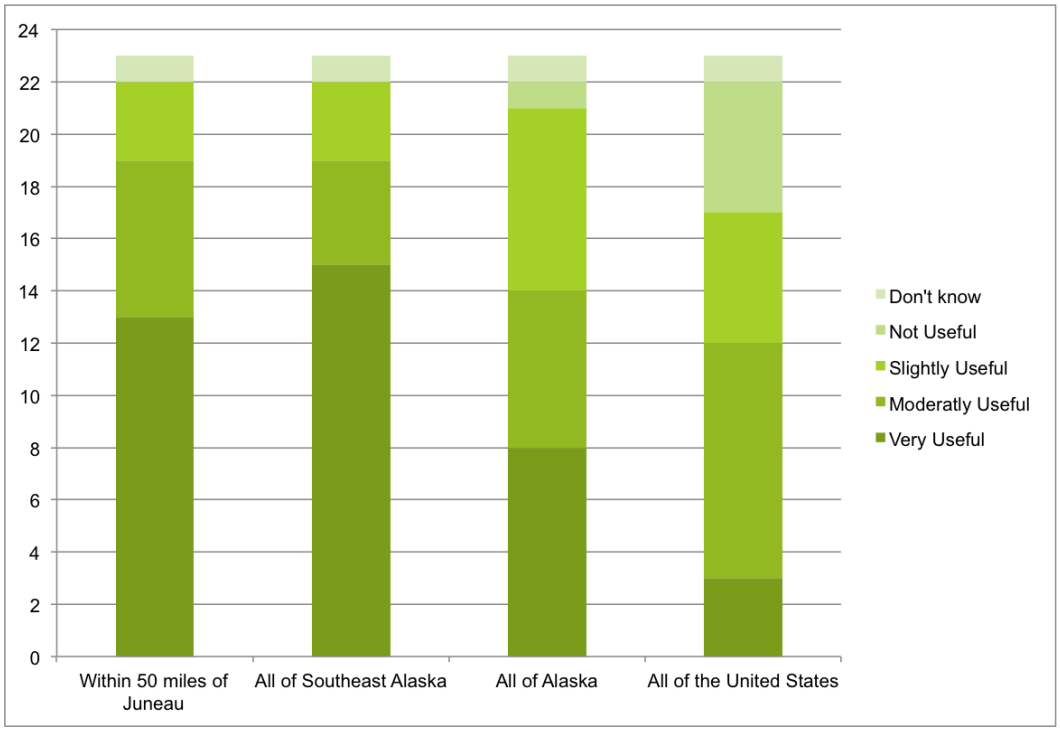


Figure 13. Spatial Scale.

Participants described that climate change information would be most useful if it was focused on the area surrounding Juneau or Southeast Alaska.

States very or moderately useful.

When describing their responses to environmental and climate change, study participants tended to describe decisions in their operations in terms of the season or in 10-20 year time scales. For example, one participant described how, “When we get within the decade mark of [glacier recession] being a reality, that’s when we would start thinking about adaptation of the company.” Another participant described how information about changes in climate should, “go back to 1950-1960. I think that’s going to give you a more realistic picture of what’s going on instead of a larger data set.” Several participants also talked about the need for seasonal forecasts that they could use when they begin to prepare for the summer peak in the tourism season.

These comments support the participants’ response to questions about the utility of climate change information at particular time scales (Figure 14). Study participants said that

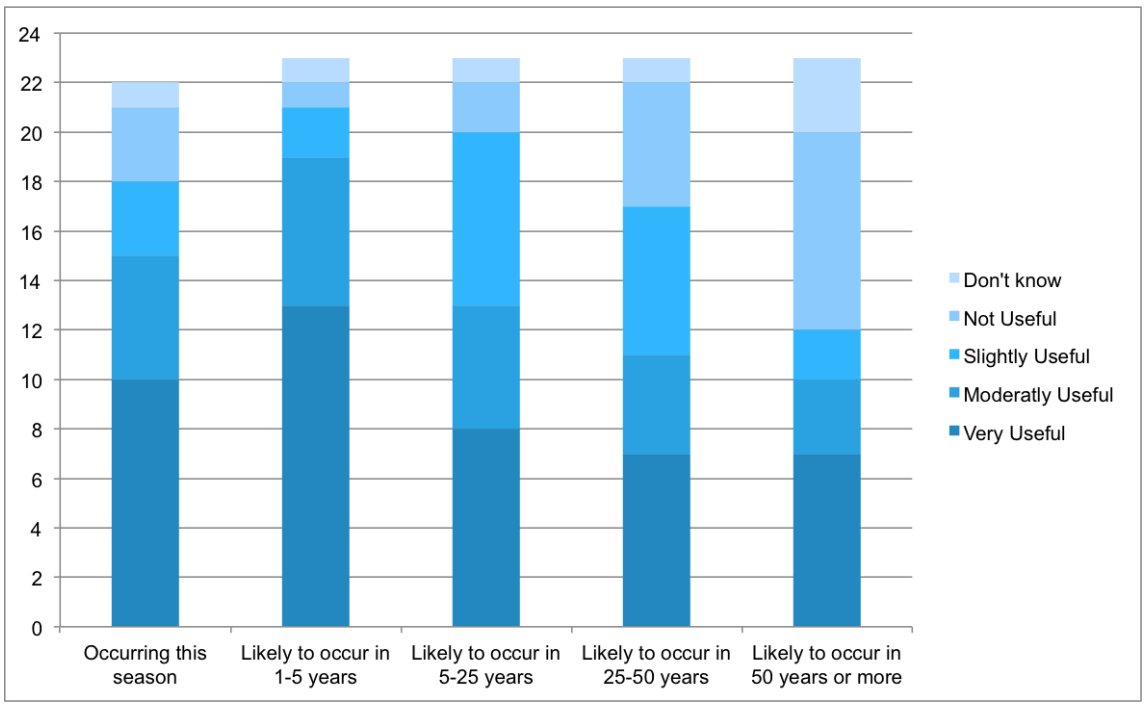


Figure 14. Temporal Scale.
Participants felt that climate change information would be most useful if it addressed the impacts occuring this season or in the coming 1-5 years.

climate change information that addresses the impacts this season and in the next 1-5 year period were most useful. When asked about the timing of climate change information, one participant noted how they would use this information annually, "when we're really making a plan for our busy season." Fifty percent or less of the participants described that information about the impacts occurring in 5-25 years, 25-50 years, or 50 years of more would be moderately or very useful.

Participants also talked about the format of the information, and the way it can be formatted to be easier to assimilate and use in their operations. Several participants described how the information needed to be written in lay terms or as one participant noted, "like a high school text book." Others added how links back to more detailed information would be useful, and described how "maps and charts that can be manipulated by the user" would be ideal. Several participants

noted that information administered during the winter could be more detailed, but that "during summer, [we] need short concise information." Another participant candidly described the format that is most useful for their organization:

> "Because it gets handed to so many people, it really needs to be concise and to the point. It needs to have the appropriate information. We're not as concerned about superfluous information. The way things get handled around here, a document gets passed to one person, gets boiled down a little bit, and passed to the next person, boiled down, next person, boiled down, next person. Ultimately when it goes to the top, there is a one-sentence abbreviated version of it. When information comes to us as the one sentence abbreviated version, it gets through everything a lot faster—so not necessarily simplistic language, but to the point."

There was not a question that explicitly addressed visitor information needs, but a quarter of the study participants described needing climate change information to give to their visitors, citing how more and more of their guests ask about climate change. One participant noted how it probably comes up daily and another added how, "Approximately four out of ten questions [from visitors] are about climate change." Study participants described taking a wide variety of different approaches to addressing visitor questions—from agreeing with whatever the guests ask to trying to educate guests about climate change. One study participant described using pictures of the glacier to talk about climate change, and how "it's nice having physical evidence that people can actually see and can't deny…when they see it, they can't deny that that change is happening." Another participant described how about half the clients are open to learning more about climate change and half are not. One participant bluntly described, "we're in the entertainment business. We are there so people can not think about it."

4.4.1.5 Credibility and Legitimacy of Information

Few of the study participants agreed that the process used to generate climate change information is legitimate and that the sources were credible, making this the most prominent communication and information-related barrier (Figure 15). Only 41% of participants agreed that the process used to generate climate change information was legitimate and an even lower percentage of people agreed that the sources were credible. Interview data neither supported nor denied these responses in a significant way. Only a couple of the study participants expressed distrust in scientists or the research process. One participant noted how, "I found that people in that business [research]…will suck information from you and not reciprocate and share back."

Rather, many of the study participants described working with local researchers in a wide range of capacities. About 50% of the tourism operators interviewed have working relationships

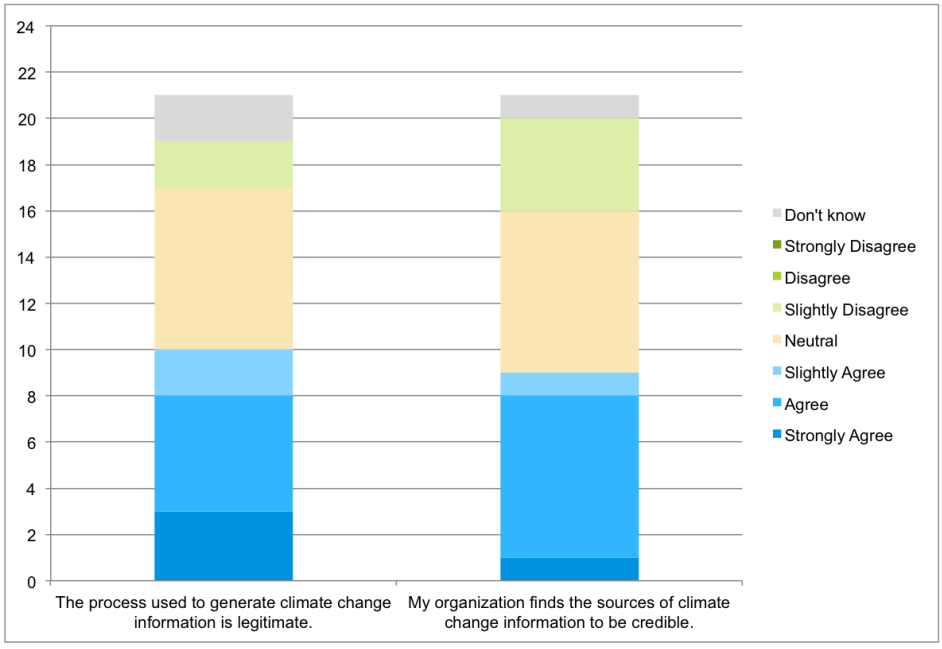


Figure 15. Credibility and Legitimacy of Climate Change Information.
This was the most significant information-related barrier. Less than half of the participants agreed that the process used to generate climate change information is legitimate and the sources are credible.

with local scientists. Several participants described how university or agency scientists' use their companies to provide transportation to their study sites. Other participants described how they aid in monitoring efforts and help set up and run weather stations. As one participant described, "We provide some info on how glaciers recede in Tracy Arm, provide daily and weekly info on glaciers, marine mammals, and marine debris. It depends on the request, but in the past we have done whale observations for a season." Another study participant noted how, "We've got such a great close working relationship with Eran [Hood] and several other [scientists]. I know there is a lot of back and forth with our guides and our pilots." In general, the tone towards research—including climate research—seemed pretty positive among those people interviewed.

CHAPTER 5
DISCUSSION

5.1 Response to Environmental and Climate Change

The results of this research agree with previous work by Tervo-Kankare (2011) and Trawöger (2014); in the tourism industry there is an awareness but generally little strategic response or planned adaptation to climate change. Similarly, this study found that a third of Juneau's nature-based tour operators are not responding to climate or environmental change. Tervo-Kankare (2011) and Trawöger (2014) found that those tourism operators and stakeholders who were responding to climate change, tended to be adopting reactive, coping measures. Similarly, in this study a little more than a third of tour operators were coping with changes in the environment, regardless of whether the impacts could be attributed to climate change. These coping responses varied widely depending on the type of tourism activities being conducted, the types of resources utilized, the means of accessing those resources, and the environmental changes being experienced. Unique to this study, four of the nature-based tour operators described engaging in more strategic, planned climate change adaptation activities. It is important to note, however, that these planned adaptation activities did not closely follow a process model nor did they involve developing a specific climate change adaptation plan. Rather, these operators described including climate change in their strategic or business plans, establishing a task force, and one described their plans for a new environmental tour.

In the literature, climate change adaptation responses have been classified different ways, but planned adaptation is generally differentiated from autonomous adaptation or coping responses (IPCC, 2007). Other studies have classified climate change adaptation responses in

different ways. For example, Trawöger (2014) classified ski tourism stakeholders in Austria into four groups depending on their actual exposure to risks and their responses: Convinced Planners, Annoyed Deniers, Ambivalent Optimists, and Convinced Wait-and-Seers. Similarly, the participants of this study fell into four different response groups. Unlike Trawöger, however, the actual exposure to risks were not measured in this study. The response classifications proposed from the results of this research are based on the perceived risks and perceived certainty in climate change that were expressed by nature-based tour operators during the interviews. The classification system proposed is supplemented with considerations from the literature on certainty and risk perception.

While there is a high degree of certainty about climate change and its causes in the scientific community, there are considerable uncertainties about the causes, extent, time scales and consequences among many non-scientists—especially when the impacts are considered at a local scale. Comments from the study participants' reflected this, and statements about climate change certainty or uncertainty were common in the interviews. For example, the majority of participants described feeling certain that most glaciers in the region were thinning and receding and that they would continue to do so. Feeling certain about this impact provoked responses by several study participants. The amount of dedication, resources, and effort applied to the response tended to depend on the perceived risks, such that those operators already perceiving high risks were more like to be planning and those who perceived it as a future risk were more likely to be coping until the risk becomes more serious. In contrast, study participants had much lower perceived certainty about the effects of climate change on salmon populations. Underlying system variability, the inability to see and directly experience impacts, knowledge of the system and drivers, and the role of non-climatic factors all moderated the participants' feelings of certainty

and perception of this particular risk. In most cases this was one of the factors that inhibited organizations from responding.

Perceived certainty has important effects on individuals' behaviors (Tversky & Shafir, 1992), and it is a necessary ingredient for promoting environmentally friendly behaviors (Hine & Gifford, 1996). Certainty in climate change knowledge has been positively correlated to climate relevant behaviors and behavioral intentions (Lubell, Vedlitz, Zaharan, & Alston, 2006; O'Connor, Bord, & Fisher, 1999). Perceived efficacy—or the certainty that an individual themselves or their group can effectively avoid risk or negative outcomes—is also a useful predictor of environmental or climate relevant behaviors (Geller, 1995; Grothmann & Patt, 2005). Direct experiences with the impacts of climate change can reinforce existing beliefs or help increase the certainty about climate change in individuals who are unsure (Myers et al., 2013).

Prior research shows that most people are averse to uncertainty and vagueness. People tend to be reluctant to act on uncertain information (Tversky & Shafir, 1992), and so the communication of climate change (where uncertainty is often inherent) can sometimes undermine action more than advance it (Hine & Gifford, 1996). Beyond inhibiting changes in behavior, uncertainty about negative future situations can actually lead to overly optimistic attitudes about ones current behavior and lead people to justify the status quo (Budescu, Rapoport, & Suleiman, 1990). Denial of the risks can occur when messages about uncertainty are communicated with the risks (Langford, 2002; Rogers, 1983) or when information about risks or potential responses threaten deeply held beliefs (Kahan et al., 2012).

Slovic, Finucane, Peters and MacGregor (2004) define risk perception as the perceived likelihood of negative consequences to oneself and society from a specific stressor—in this case

climate change and related issues. Individuals perceive risks through both the quick, intuitive experiential system and through the slower, more logical analytic system (Slovic et al., 2004). These two processes overlap and interact (Slovic et al., 2004). In general, perceptions of higher risk are related to behaviors that aim to reduce the risk (O'Connor et al., 1999). These relationships are complex, however, and experience, knowledge, general environmental beliefs, and other stressors can all shape risk perception and affect intended or actual behavioral responses (Moser, 2014).

There is a significant body of research on certainty and on risk, but only a handful of studies look at the interaction between risk, certainty, and responses to climate change (O'Connor et al., 1999; Pidgeon & Fischhoff, 2011). The results of this study demonstrate that risk perception and certainty can, at least in part, explain responses to climate change and related decisions. The proposed framework (Figure 16) emerged from a qualitative analysis of statements about perceived certainty in climate change and the perceived risks of climate change. Four groups were identified, including: Planner, Copers, Optimists, and Deniers. Each segment is described in the sections that follow, and includes a specific example of an actual nature-based tour operator's perception of risk, certainty, and response that was documented during the interviews[1]. These specific examples were selected to tangibly demonstrate how perceived certainty and risk can influence behavior and response.

5.1.1 Coping: "What we're doing works."

The participants in the Coping category (n=8) were certain that climate change was occurring, but described how climate change is presently a low risk to their operations. Some of these participants described experiencing impacts of climate change, but generally felt like the

1 Some details are purposefully omitted from the examples to maintain participant confidentiality.

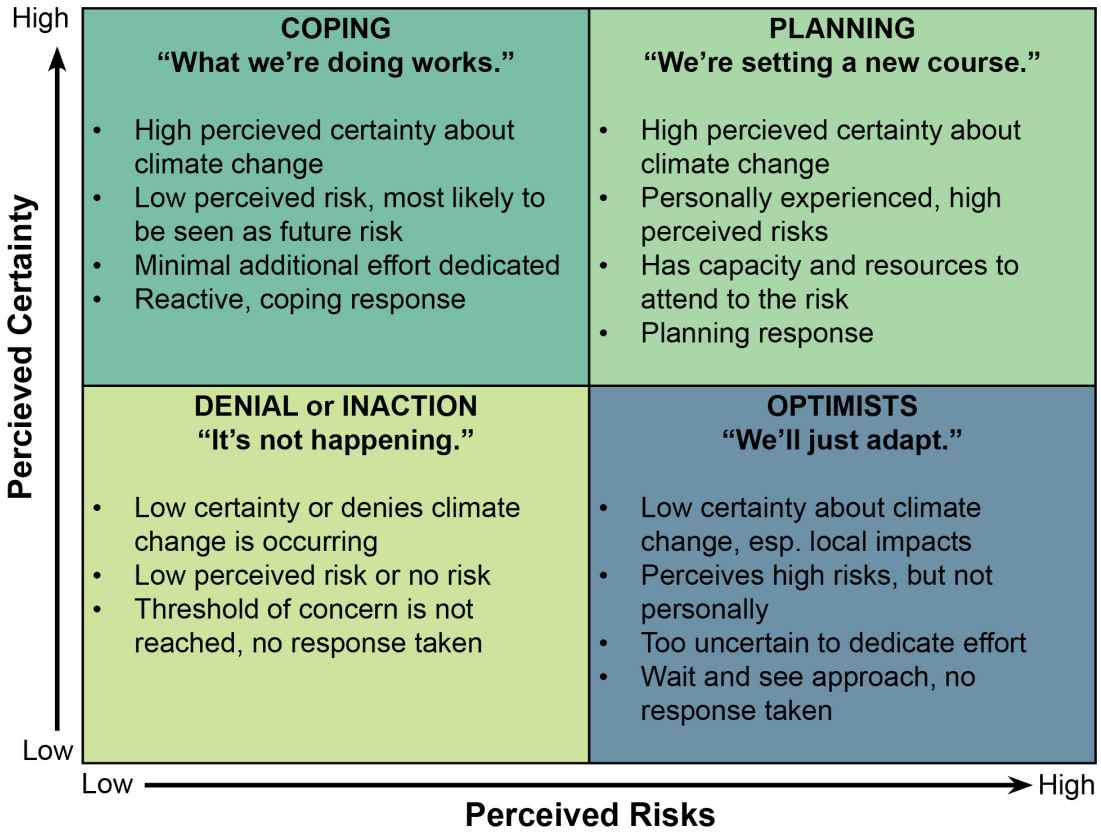


Figure 16. Perceived Risk, Perceived Uncertainty, and Response Framework.
A response framework outlines the four climate change response groups, identified by their perceived certainty in climate change information and their perceived climate change-related risks.

impacts would pose larger risks sometime in the future. Both icefield-based and ocean-based operators fell into this category, and they described the ways they were coping with changes in the environment. They explained how they changed the location of their operation depending on glacier stability and snowfall amounts, cancelled tours if they were unable to travel, or participated in climate change mitigation or conservation activities. All but one of these participants was in the Concerned group of the Global Warming's Six Americas. The results of this research are compatible with this assessment as members of the Concerned group tend to believe that climate change is occurring, but are less likely than the Alarmed group to believe that it is human caused and that their family or themselves are at risk (Roser-Renouf et al., in press).

For example, there is an icefield-based tour operator who is highly aware of climate change. They realize that the glaciers they travel to are being affected by climate change, and as they disappear, they recognize that the landscape will be less appealing to visitors. They do what they can to reduce their fuel usage, minimize the number of flights they take, and try to minimize the environmental impact of their company. However, adapting to changes in the environment is not something they are currently doing, citing that they adjust to current issues and not those that are 15-20 years in the future. They use two or more locations on the icefield and switch between them as the snow cover changes during the summer. They have rules in place that dictate when they can and cannot fly, and so they are accustomed to responding to changes in weather on a daily basis. Even if conditions become less appropriate for flying, they have to follow the Federal Aviation Administration rules and will have to cope with those changes.

5.1.2 Planning: "We're setting a new course."

The participants in the Planning group (n=4) are confident that climate change will create significant risks for their operations, and they are certain about climate change and the types of impacts they face. Many of these participants described experiencing impacts, and they attribute these impacts to climate change. Participants of this group were more likely to describe how they were seeking information about climate or talked about other changes in their lifestyle in response to climate change. This group is responding strategically, and has planned climate change adaptation efforts for their operations. They were doing this by including climate change in their business plan, forming a task force to explore information and options, included climate change in a five-year plan, or are planning a new environmental business. They are a small subset of the whole, but their tour activities tended to fall across the different sectors—icefield, land, and ocean-based. Participants were most likely to be in the Alarmed—the most engaged—segment of

the Global Warming's Six Americas, which agrees with how they were responding to the risks of climate change. Interestingly, one participant in the Planning group was in the Disengaged group of the Global Warming's Six Americas, and this may be an indication that their company was addressing climate change even though it may not have fit closely with their personal beliefs or that economic or other factors led them to this decision.

For example, there is a land-based tour operator who conducts guided hikes to the terminus of the Mendenhall Glacier where they put on crampons and hike around on the glacier. Since the glacier formed a lake nearly a century ago, it has rapidly receded back from the trailheads, visitor center, and parking lot on the far end of the lake. Changes in climate are also causing the glacier to thin, making it harder to see from one of the main vantage points on the trail. Cruise ship passengers have a limited amount of time in port, and as the glacier becomes harder to see and takes longer to get to, the tour operator has started to think about ways to do the tour differently to decrease the amount of time it takes to get to the glacier. They are working with the Forest Service to update their commercial use permit to conduct new activities at the glacier. The tour operator has included a section about climate change in their business plan, and takes the risks seriously. Recent glacial outburst floods have also forced them to change the route of some of their guided hikes for short periods of time.

5.1.3 Optimists: "We'll just adapt."

The Optimists (n=5) see climate change as a high risk, and but they tend to see climate change as a global threat and not a local issue. This perspective introduces a lot of uncertainty in their understanding about climate change, the impacts, and what it means for their operations. They are not responding because they don't see anything to respond to, but many of the partici-

pants in this group were optimistic that they would be able to adapt to future changes in the environment. Participants of this group were likely to talk about how they always adapt to whatever happens, and if they see something to respond to, they'll respond. All of the participants of this group were ocean-based operators. While one was Alarmed and another was Cautious, most of the participants of this group were in the Concerned group of the Global Warming's Six America's. Like those participants who were coping with changes in the environment, they don't feel like climate change presents direct threats. The uncertainty that these participants are experiencing could actually be contributing to their overly optimistic attitudes (Budescu et al., 1990).

For example, there is an ocean-based tour operator that charters boats to clients who want to explore the waters on their own and also helps customers find boats from other companies to fit their needs. While they don't focus specifically on fishing, their clients may use the boats to fish, watch whales, camp, or visit tidewater glaciers. They are accustomed to operating in a wide range of conditions and cancelling or revising itineraries based on weather is a regular part of their business. The operator is aware of the risks of climate change, but thinks about it as a global issue. They don't feel particularly threatened by local changes to the weather or environment, citing how this is just how Juneau is—there is a lot of variability in the weather that they are used to dealing with. They are, however, curious about whether more glacier melting would mean more icebergs, because icebergs can make boat navigation more challenging and make travel in Glacier Bay and Tracy Arm riskier. They aren't responding to or planning for climate change, because they don't see specifically and with certainty how it will impact their operation or how they can make a difference.

5.1.4 Denial or Inaction: "It's not happening"

The participants in the Denial or Inaction group (*n*=7) see climate change as a low risk or not a risk at all. They also are also very uncertain about climate change, react to its mention with caution, or outright deny its occurrence. Denial was common among about half of this group, and can occur when risks or risk responses threaten deeply held values (Kahan et al., 2012). The reminder of participants in this group may have acknowledged the occurrence, but felt like there was nothing that could be done about climate change regardless of whether it was happening or not. Most of the participants in this group were ocean-based operators, but this group also included some land and icefield-based operators. Not surprisingly, the participants in this group tended to fall into the less concerned (Doubtful, Dismissive, and Cautious) groups of the Global Warming's Six Americas (Maibach et al., 2011b).

For example, there is an ocean-based operator that doesn't think that changes in the environment impact their operation, although they wonder where the king salmon went. They explain that none of the scientific answers matter, because no one really knows, adding that over fishing is probably the reason that salmon populations are declining. They describe how changes in glaciers have been occurring for centuries, and how if climate change is happening they don't care. They describe that they'll be dead before climate change impacts them and their business, but acknowledges that it might be an issue for their grandchildren. They think climate change is happening, but that it is a natural phenomenon that will have minimal impact on human beings and is being blown out of proportion by the government.

5.2 Pathways to Communicate for Climate Change Adaptation

This research suggests that percieved risks and percieved certainty in climate change

information are important factors for motivating responses to climate change. If the goal of climate change adaptation communication is to prompt a response, then communication strategies that help audiences better understandings of the risks and that foster greater certainty about the causes, impacts, and responses, should lead to more adaptation responses or improved capacity to adapt. These responses are likely to vary for different audiences. For example, increasing the certainty of some Optimists may lead them to identify local risks and develop a more strategic approach to climate change adaptation planning. For other Optimists, even after they become more certain, their actual risks may remain low. In these cases, identifying coping strategies or building adaptive capacity may be suitable goals for the communication effort. Percieved certainty and the percieved risks are likely to vary through time and by particular issues, so audiences could concievably move through different parts of this framework through time or as they encounter differnt issues.

There has been considerable theory development and experimental research in the areas of certainty and risk, and climate change adaptation communication sits at the intersection of a lot of work that has already been done on communicating risks, mitigation, and conservation more generally (Heinrichs, 2010). There is not a shortage of research that could be pulled together to create specific communication guidelines for each of these groups, and some communication strategies and effective frames have already been identified for communicating with similar groups (Roser-Renouf et al., in press). Previous research has also looked at the effects of different spatial frames on climate change communication and perceptions (O'Neill & Hulme, 2009; Scannell & Gifford, 2011). This framework is one attempt to organize this broad body of research, but whether these communication approaches successfully increase literacy and certainty, promote adaptation, or build adaptive capacity is still a question to be tested.

This framework is not prescriptive; there are still likely to be a variety of people with different values, goals, and barriers in each quadrant. Individuals develop their understandings of climate change from a combination of experience and intermediaries like other people and the mass media (Moser, 2014). The understandings that individuals develop are shaped by their culture, society, and historical legacies (Myers et al., 2013; Whitmarsh, 2011). Depending on these underlying values and beliefs, individuals can respond to place-specific threats in many different ways that are not always conducive to behavior change (Moser, 2014). Because of this, a truly engaging communication process is important for climate change adaptation. Using participatory research approaches, visualizations, asking questions, listening, and agreeing on definitions of key terms, such as adaptation or conservation, are guidelines that should transcend the communication strategies proposed. Nonetheless, what follows are some specific recommendations for communicating about climate change adaptation with audiences from each segment of the proposed response framework: Planners, Copers, Optimists, and Deniers.

5.2.1 Communicating with Planners

Judging by this research, national opinion polls, and other similar studies, Planners are likely to be the minority (Leiserowitz et al., 2013; Roser-Renouf et al., in press; Trawöger, 2014), but because they are paying attention the issue personally and professionally, they are probably most likely to seek information about climate change adaptation. Climate change has personal relevance to this group, and dual processing theories (Petty & Brinol, 2012) suggest that this is an essential step towards engaging in the communication of more complex information. Communication with this group should be sophisticated and action oriented, because they are likely to already be certain about the science. Jointly identifying and clarifying the actual risks may be important, because action can be motivated by improperly identified risks (O'Connor, Bord, &

Fisher, 1998). Because they are already responding, they may have already encountered barriers and may be seeking information to overcome these barriers. Research has shown that individuals such as these could become highly influential opinion leaders and sources for information on a local level, particularly among groups who would be less willing to engage with research scientists or institutions outside theirs (Roser-Renouf et al., in press).

5.2.2 Communicating with Copers

Although they are pretty certain about climate science and local impacts, Copers do not see climate change as an immediate risk. They are able to use their normal operations and risk management activities to cope with the environmental changes they are experiencing. These short term coping measures may be sufficient, but may lead to path dependencies that are unlikely to build long-term adaptive capacity in the system (Moser, 2014). Because this audience is already paying attention to climate change, like the Planners, they are probably open to more complex information and learning about actions they can take. Communication should emphasize the local impacts, and connect participants' understandings of place to present or near future (less than 10-20 year) impacts. Communicating about local threats, however, should be accompanied by discussion about efficacy (Roser-Renouf et al., in press). Recent research shows that threatening information only leads to behavior change when efficacy is high (Peters, Ruiter, & Kok, 2013). Conversations about efficacy should resonate with this audience because they have already been taking action, but because climate change usually means slow and continual change, the potential thresholds and tipping points where coping no longer works should be discussed and identified. Because they percieve to be certain, but see the risks as far off, communication efforts should aim to build climate literacy so that the audience can occasioanlly reevaluate the immediacy of their risks and whether the coping mechanisms that have been adopted maintain

long term adaptive capacity.

5.2.3 Communicating with Optimists

Optimists see the risks, but believe that the risks are global and not local in nature. Their uncertainty in the risks is likely combatted with optimism, which is not conducive to adaptation behaviors or responses (Budescu et al., 1990). For this group, climate change needs to be made local and the local impacts should be explained concretely, with visualizations, geographic relevance, and personal stories (Scannell & Gifford, 2011). They're likely to want to maintain the status quo, so framing the risks and actions should be focused on positive outcomes like economic benefits, risk management, or community building (Moser, 2014). For example, Kahneman and Tversky (1979) found that when the messages are focused on the gains, people would be more likely to make choices. With this group, if messages are focused on loss, the participants may be more likely to avoid choices and take a "wait-and-see" approach. Planners may serve as effective messengers for this group. By talking about how they are responding and planning, they could help build collective efficacy by talking about what they are capable of doing together.

5.2.4 Communicating with Deniers

Unlike the other three groups, who mostly fell into the Concerned or Alarmed—high issue engagement—groups of the Global Warming's Six Americas, the participants in this group actively deny that climate change is occurring or deny that it's a human-caused phenomenon. They may also feel like they are unable to do anything about the issue. This particular audience likely pays little attention to climate change and is probably unwilling to dedicate much energy to thinking about it, so communication efforts will have to rely on low-commitment, peripheral information processing and cues, like visuals, humor, or respected messengers (Petty & Brinol,

2012). This group is unlikely to trust unfamiliar sources, so identifying appropriate messengers and organizations to share information is very important (Roser-Renouf et al., in press). For some people in this group, cultural cognition of risk or motivated reasoning could filter out information that is not congruent with deeply held beliefs (Whitmarsh, 2011; Myers et al., 2013). Creating climate literacy is less likely with this group because of the protected cognition.

5.3 Future Issues for Climate Change Adaptation Communication

Notwithstanding these specific recommendations, the results of this research have an additional implication for communicating about climate change adaptation, and that is the term adaptation itself. Although they were asked more generally about responses, the study participants described adaptation, mitigation, and conservation activities interchangeably. Moser (2014) and Ford et al. (2013) both acknowledge that what constitutes adaptation is fragmented, both in the literature and in public discourse. The results of this study confirm what Moser (2014) recently suggests—that further work should be done to assess how adaptation is understood and perceived by different audiences. The results of this research also support Moser's (2014) discussion about how the distinction between adaptation and mitigation may not be practical beyond an academic or technical realm. In this study, even after the definition of adaptation was clarified, some participants continued to describe general conservation and climate change mitigation activities—not interpreting the distinction that was intended. One participant described how, "I think what we are doing is responding to the environment. We are not so much responding to climate change, but responding to the potential of climate change or harming the environment."

This type of research would likely benefit by finding more concrete ways to talk about these different activities—adaptation, mitigation, conservation, and stewardship—with differ-

ent audiences. In addition to being interpreted widely, in her literature review, Moser (2014) also found that different communities favor one term over another, and may avoid using mitigation or adaptation altogether for terms like hazard mitigation or disaster preparedness. Because the words have been associated with climate change in public discourse, their use may elicit immediate positive or negative connotations depending on the audience. This was apparent during the interviews conducted during this study, and it would be useful to address the interpretation of these terms in future research. The challenge of communicating about adaptation, mitigation, conservation, and responses more generally may have limited some of the results of this research, and there definitely needs to be more focused research to identify the best ways to talk to different audiences about adaptation (also called for by Moser 2014).

Beyond communicating adaptation, classifying an action as climate change adaptation is also a challenge for future research. "Adaptation" is unlike its "mitigation" counterpart, in that it cannot be measured in carbon contributed or saved per a particular activity (Ford et al 2013). Some of the early adopters of climate change adaptation planning were agencies and other public sector organizations, and many of these groups took a very strategic, process-orientated approach to developing specific documents dedicated to adaptation planning. This may have shaped some of the previous literature and frameworks for evaluating climate change adaptation. In this study, however, the tour operators who were planning for climate change were talking about their response in the context of their business plans. As climate change adaptation moves into new organizations—particularly the private sector—and beyond the early adopters, it will be important to investigate how adaptation is being done, formatted, or described differently. These are still important efforts, and they should not be discounted just because they may not fit the existing idea of what makes an adaptation plan or what makes adaptation planning successful.

CHAPTER 6
CONCLUSIONS

The goal of this study was to determine how to provide useful climate change information for nature-based tour operators by studying the types of environmental changes they perceived, the responses they were taking, and the information that they needed. According to the data presented in this study, nature-based tour operators are observing and responding to climate and environmental change in and around Juneau, Alaska. The organizational responses to these changes varied from inaction and denial to uncertain optimism, and from coping to strategic planning for climate change. Using data about certainty in climate change information and the perceived risks to the organization, this study proposes a framework to classify climate change responses for the purpose of generating meaningful information and communication processes that promote adaptation and build adaptive capacity in the tourism sector. The results of this study demonstrate that science communication research has an important place in climate change adaptation and sustainability science.

The study began with an interest in improving climate change communication and engagement with Juneau's nature-based tour operators. In order to do this, an understanding of how nature-based tour operators' perceived climate and environmental change and their response to these changes were needed. To answer these questions, twenty-four of Juneau's nature based tour operators, representing a diverse set of individuals and organizations, participated in semi-structured interviews. The interviews also included some multiple choice questions to identify some specific information and communication-related barriers to responding to climate change and to classify the participants' climate change views using the nationally administered Global Warm-

ing's Six America's survey tool. Qualitative responses were coded and analyzed using NVivo, and the other data were analyzed using Excel and SPSS.

The majority of nature-based tour operators described how changes in the environment impacted their operations. Cold, rainy, and foggy conditions were identified as a problem by many operators—but were challenges that few were able to readily respond to. The majority of operators recognized that glaciers were slowly disappearing, and that the loss of glaciers would negatively affect the landscape. This secondary or indirect effect of climate on the resources for tourism would significantly impact the state and regional tourism industry and represents a tipping point in the regional social-ecological system of Southeast Alaska. Other changes in the environment were observed, and the observations were often unique to different groups of operators depending on the way they accessed their resources and the types of resources they relied on. For example, icefield-based operators were concerned about snow cover in the summer, ocean-based operators were concerned about salmon populations, and land-based operators were concerned about glacier access. The results of this study represent a part of one community of tour operators, and an increased number of samples would strengthen the understanding that is beginning to be developed on how climate change will directly and indirectly affect Alaska's tourism industry.

Nature-based tour operators identified a wide range of ways that they were responding to climate change. Their responses often transcended the boundaries of adaptation, mitigating, conservation, and environmental stewardship, suggesting that more work is needed to identify the ways that different groups of people define these terms and whether they are practical in all applications of climate change adaptation research and planning practice. Like other studies of the tourism industry have shown, planned adaptation activities are not being widely adopted by

members of the tourism industry. About a third of the tour operators interviewed in this study were autonomously adapting or coping with changes in the environment by relying on existing risk management frameworks and practices. Further work on climate change responses in the private sector is needed; there are relatively few studies and some indication that the approaches to climate change adaptation may vary.

The responses to climate and environmental change varied depending on the participants' certainty in climate change and its impacts and their perception of the climate change risks. Participants with high certainty and high perceived risks were actively planning for climate change by creating task forces to explore information, including climate change in existing plans, or planning new businesses. Participants with high certainty in climate change, but low perceived risks because the climate threat was seen as distant in time were often coping with climate change by relying on existing operational and risk management practices. Participants with low certainty, but high perceived risks, tended to see the risks as spatially distant from themselves. These participants were optimistic that they would be able to respond if the need arose. Each of these three groups were convinced that climate change was happening, but the last group was only likely to believe that climate change was happening. This final group had low certainty and low perceived risks and generally denied the existence of climate change or felt like nothing could be done. While this is an interesting new approach to studying and analyzing responses to climate change, it also has potential to serve as a framework for climate change communication efforts that promote adaptation and adaptive capacity.

The results of this study make general recommendations about what makes information useful to this particular audience, including crafting information at regional scale, for a seasonal to approximately 20 year time horizon, us lay terminology, and make accessible in places that

tourism operators already go for information, such as weather websites. While these results have great practical utility for communication practitioners, it was synthesizing the perceived risks and certainty that made it possible to integrate the research from science communication into this response framework. Science communication literature spans several academic traditions and sub disciplines and can be fragmented; the results make it possible to integrate relevant research and lessons from practice. The study and practice of climate change communication for adaptation is relatively new, and requires further exploration of the linkages between experience, risk perception, behavior, certainty, adaptive capacity, and communication.

The vague and sometimes not clearly defined terminology used throughout this study is a limitation of these results. It is hard to draw inferences between concepts like climate change, response, and adaptation when the terms themselves can be interpreted and defined widely. More attention should be paid to the definition of these terms in future climate change adaptation practice and research. Many of the definitions from the literature are vague or may be more theoretical in nature, and discussing and defining these key terms with the study participants could be one way to improve the interpretation of the results of similar research. As these somewhat abstract ideas are interpreted in different ways by different groups of people, they will continue to create challenges in advancing practice and research in climate change adaptation if investigators and their study participants do not have clear, agreed upon understandings of these ideas.

This research and only a couple of prior studies have looked at the effects of climate change on tourism in Alaska, and this is an area ripe for further research that can be economically significant for the state and some regions of Alaska. Prior work has indicated that changes in climate could benefit tourism in Alaska, but these results uncovered some of the risks. Working with communities, biologists, physical scientists, and social and economic scientists now have

a foundation to better assess the opportunities and vulnerabilities of Alaska's tourism industry to changes in climate. The results of this research did not clearly identify the effects of extreme events or identify thresholds in the social-ecological tourism system. By studying the environmental conditions and tour operators in state, an understanding of supply-side issues can be developed. The demand-side, however, still has many questions. To what extent is the changing environment motivating travel to Alaska? How are visitors responding to the changing environment and what role do destinations play in moderating these experiences?

Finally, there are many state and regional tourism industry groups and organizations. One of the most memorable aspects of this research was the tour operators surprise and appreciation at being included in a study of this nature and working with someone from the university. This might be an indication that they are open to further engagement, and the independent operators as well as the industry organizations should be engaged in dialogue, research, and information sharing about climate change in Alaska.

As a regionally focused study, the results of this research have practical importance by providing several recommendations about how scientists and other organizations studying and planning for climate change can engage in providing useful information to nature-based tour operators. The results of this research also lay the groundwork for future studies on the impacts of climate change on Alaska's tourism industry. Changes in glaciers are important, but for independent nature-based tour operators the impacts may be very specific to their individual operations. More broadly, this research begins to fill an important gap between climate change adaptation and communication, by identifying two factors—certainty and risk—that have both been extensively considered in the communication and the adaptation literature, but rarely united. The framework proposed in this study unites these ideas while creating guidelines for improving

climate change communication practice.

LITERATURE CITED

Adger, W. N., Arnell, N. W., & Tompkins, E. L. (2005). Successful adaptation to climate change across scales. Global Environmental Change, 15(2), 77-86. doi:10.1016/j.gloenvcha.2004.12.005

Adger, W. N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D. R., . . . Wreford, A. (2008). Are there social limits to adaptation to climate change? Climatic Change, 93(3-4), 335-354. doi:10.1007/s10584-008-9520-z

Albano, C., Angelo, C. L., Strauch, R. L., & Thurman, L. L. (2013). Potential effects of warming climate on visitor use in three Alaskan national parks. Park Science, 30(1), 36-44.

Amelung, B., Nicholls, S., & Viner, D. (2007). Implications of global change on for tourism flows and seasonality. Journal of Travel Research, 45(3), 285-296.

Archie, K. M. (2013). Mountain communities and climate change adaptation: Barriers to planning and hurdles to implementation in the Southern Rocky Mountain Region of North America. Mitigation and Adaptation Strategies for Global Change. doi:10.1007/s11027-013-9449-z

Archie, K. M., Dilling, L., Milford, J. B., & Pampel, F. C. (2012). Climate change and western public lands: A survey of U.S. federal land managers on the status of adaptation efforts. Ecology and Society, 17(4). doi: 10.5751/es-05187-170420

Arendt, A. A. (2011). Assessing the status of Alaska's glaciers. Science, 332(6033), 1044-1045. doi:10.1126/science.1204400

Arendt, A. A., Luthcke, S., Gardner, A., O'Neel, S., Hill, D., Moholdt, G., & Abdalati, W. (2013). Analysis of a GRACE global mascon solution for Gulf of Alaska glaciers. Journal of Glaciology, 59(217), 913-924. doi:10.3189/2013JoG12J197

Arendt, A. A., Walsh, J., & Harrison, W. (2009). Changes of glaciers and climate in Northwestern North America during the Late Twentieth Century. Journal of Climate, 22(15), 4117-4134. doi:10.1175/2009jcli2784.1

Barclay, D. J., Wiles, G. C., & Calkin, P. E. (2009). Holocene glacier fluctuations in Alaska. Quaternary Science Reviews, 28, 2034-2048.

Berkhout, F., Hertin, J., & Gann, D. M. (2006). Learning to adapt: Organisational adaptation to climate change impacts. Climatic Change, 78(1), 135-156. doi:10.1007/s10584-006-9089-3

Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change? Global Environmental Change, 21(1), 25-33. doi:10.1016/j.gloenvcha.2010.09.012

Berthier, E., Schiefer, E., Clarke, G. K. C., Menounos, B., & Rémy, F. (2010). Contribution of Alaskan glaciers to sea-level rise derived from satellite imagery. Nature Geoscience, 3, 92-95. doi:10.1038/ngeo737

Biesbroek, G. R., Klostermann, J. E. M., Termeer, C. J. A. M., & Kabat, P. (2013). On the nature of barriers to climate change adaptation. Regional Environmental Change, 13(5), 1119-1129. doi:10.1007/s10113-013-0421-y

Bigano, A., Hamilton, J. M., & Tol, R. (2006). The impact of climate change on holiday destination choice. Climatic Change, 76(3), 389-406.

Borah, P. (2011). Conceptual issues in framing theory: A systematic examination of a decade's literature. Journal of Communication, 61(2), 246-263. doi:10.1111/j.1460-2466.2011.01539.x

Brossard, D., & Lewenstein, B. V. (2010). A critical appraisal of models of public understanding of science. In L. Kahlor & P. A. Stout (Eds.), Communicating science new agendas in communication (pp. 11-39). New York: Routledge.

Budescu, D. V., Rapoport, A., & Suleiman, R. (1990). Resource dilemmas with environmental uncertainty and asymmetric players. European Journal of Social Psychology, 20, 475-487.

Burakowski, E., & Magnusson, M. (2012). Climate impacts on the winter tourism economy in the United States. Retrieved from Natural Resource Defense Council website: http://www.nrdc.org/globalwarming/files/climate-impacts-winter-tourism-report.pdf

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., . . . Mitchell, R. B. (2003). Knowledge systems for sustainable development. Proceedings of the National Academy of Sciences of the United States of America, 100(14), 8086-8091. doi:10.1073/pnas.1231332100

Chapin, F. Stuart, Kofinas, G. P., & Folke, C. (2009). Principles of ecosystem stewardship. New York: Springer.

Dugan, D., Fay, G., & Colt, S. (2006). Nature-based tourism in Southeast Alaska: Results from 2005 and 2006 field study. Retrieved from Institute for Social and Economic Research University of Alaska Anchorage: http://www.iser.uaa.alaska.edu/Publications/SEnbt_final.pdf

Ekstrom, J. A., Moser, S. C., & Torn, M. (2011). Barriers to climate change adaptation: A diagnostic framework. Retrieved from California Energy Commission website: http://www.energy.ca.gov/2011publications/CEC-500-2011-004/CEC-500-2011-004.pdf

Elsasser, H., & Bürki, R. (2001). Climate change as a threat to tourism in the Alps. Climate Research, 20, 253–257.

Entman, R. (1993). Framing: Toward clarification of a fractured paradigm. Journal of Communication, 43(4), 51-58.

Finzi Hart, J. A., Grifman, P. M., Moser, S. C., Abeles, A., Myers, M. R., Schlosser, S. C., & Ekstrom, J. A. (2012). Rising to the challenge: Results of the 2011 coastal California adaptation needs assessment. Retrieved from Stanford Woods Institute for the Environment website: http://woods.stanford.edu/sites/default/files/files/CACoastalAssessmentResults.pdf

Fischer, A., Olefs, M., & Abermann, J. (2011). Glaciers, snow and ski tourism in Austria's changing climate. Annals of Glaciology, 52(58), 89-96.

Fischer, J. (2007). Current issues in the interdisciplinary research field of climate change and tourism. Retrieved from Tourism Vision website: http://www.tourism-climate.de/article-tourism-climate.htm

Ford, J. D., Berrang-Ford, L., Lesnikowski, A., Barrera, M., & Heymann, S. J. (2013). How to track adaptation to climate change: A typology of approaches for national-level application. Ecology and Society, 18(3). doi:10.5751/es-05732-180340

Geller, E. Scott. (1995). Integrating behaviorism and humanism for environmental protection. Journal of Social Issues, 51(4), 179-195. doi:10.1111/j.1540-4560.1995.tb01354.x

GMA Research Corporation. (May, 2011). Images of Alaska 2011. Paper presented to the Alaska Travel Industry Association, Anchorage, Alaska.

Grothmann, T., & Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. Global Environmental Change, 15(3), 199-213. doi:10.1016/j.gloenvcha.2005.01.002

Hall, C. M., & Boyd, S. (2005). Chapter 1: Nature-based tourism in peripheral areas: Introduction. In C. M. Hall & S. Boyd (Eds.), Nature-based tourism in peripheral areas: Development or disaster (pp. 3-20). Tonawanda, NY, USA: Channel View Publications.

Haufler, J. B., Mehl, C. A., & Yeats, S. (2010). Climate change: Anticipated effects on ecosystem services and potential actions by the Alaska Region, U.S. Forest Service. Ecosystem Management Research Institute, Seely Lake, MT. Retrieved from US Forest Service website: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_038171.pdf

Heinrichs, H. (2010). Climate change and society—Communicating adaptation. In M. Gross & H. Heinrichs (Eds.), Environmental sociology: European perspectives and interdisciplinary challenges (pp. 323-344). New York: Springer.

Hine, D. W., & Gifford, R. (1996). Individual restraint and group efficiency in commons dilemmas: The effects of two types of environmental uncertainty. Journal of Applied Social Psychology, 26(11), 993-1009. doi:10.1111/j.1559-1816.1996.tb01121.x

Hinzman, L. D., Bettez, N. D., Bolton, W. R., Chapin, F. S., Dyurgerov, M. B., Fastie, C. L., . . . Yoshikawa, K. (2005). Evidence and implications of recent climate change in northern Alaska and other Arctic regions. Climatic Change, 72(3), 251-298. doi:10.1007/s10584-005-5352-2

Hood, E., & Berner, L. (2009). Effects of changing glacial coverage on the physical and biogeochemical properties of coastal streams in southeastern Alaska. Journal of Geophysical Research, 114(G3). doi:10.1029/2009jg000971

Hood, E., Fellman, J., Spencer, R. G. M., Hernes, P. J., Edwards, R., D'Amore, D., & Scott, D. (2009). Glaciers as a source of ancient and labile organic matter to the marine environment. Nature, 462(7276), 1044-1047. doi:10.1038/nature08580

Hood, E., & Scott, D. (2008). Riverine organic matter and nutrients in southeast Alaska affected by glacial coverage. Nature Geoscience, 1(9), 583-587. doi:10.1038/ngeo280

Hulme, M. (2009). Why we disagree about climate change. New York: Cambridge University Press.

Interagency Working Group on Coordination of Domestic Energy Development and Permitting in Alaska. (2013). Managing for the future in a rapidly changing arctic: A report to the president. Retrieved from Alaska Center for Climate Assessment and Policy website: https://accap.uaf.edu/?q=webinar/managing-future-rapidly-changing-arctic-report-president

IPCC. (2007). Appendix I: Glossary. Retrieved from Intergovernmental Panel on Climate Change website: https://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf

IPCC. (2013). Summary for policymakers. In T. F. Strocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex & P. M. Midgley (Eds.), Climate change 2013: The physical science basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Kahan, D., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. Nature Climate Change. doi:10.1038/nclimate1547

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometricas, 47(2), 263-291.

Kelly, B. P., Ainsworth, T., Boyce, D.A., Jr., Hood, E., Murphy, P., & Powell, J. (2007). Climate change: Predicted impacts on Juneau. Retrieved from city/borough of Juneau website: http://www.juneau.org/clerk/boards/Climate_Change/CBJ%20_Climate_Report_Final.pdf

Kiem, A. S., & Austin, E. K. (2013). Disconnect between science and end-users as a barrier to climate change adaptation. Climate Research, 58(1), 29-41. doi: 10.3354/cr01181

Knapp, C. N., & Trainor, S. F. (2013). Adapting science to a warming world. Global Environmental Change, 23(5), 1296-1306. doi:10.1016/j.gloenvcha.2013.07.007

Koenig, U., & Abegg, B. (1997). Impacts of climate change on winter tourism in the Swiss Alps. Journal of Sustainable Tourism, 5(1), 46-58.

Langford, I. H. (2002). An existential approach to risk perception. Risk Analysis, 22, 101-120.

Larsen, C. F., Motyka, R. J., Arendt, A. A., Echelmeyer, K. A., & Geissler, P. E. (2007). Glacier changes in southeast Alaska and northwest British Columbia and contribution to sea level rise. Journal of Geophysical Research, 112(F1). doi:10.1029/2006jf000586

Leiserowitz, A., Maibach, E. W., Roser-Renouf, C., Feinberg, G., & Howe, P. (2013). Global warming's six Americas in September 2012. Retrieved from Yale School of Forestry & Environmental Studies website: http://environment.yale.edu/climate-communication/article/Six-Americas-September-2012

Lemelin, H., Dawson, J., Stewart, E. J., Maher, P., & Lueck, M. (2010). Last-chance tourism: the boom, doom, and gloom of visiting vanishing destinations. Current Issues in Tourism, 13(5), 477-493. doi:10.1080/13683500903406367

Lohmann, M., & Kaim, E. (1999). Weather and holiday destination preferences: Image, attitude, and experience. Tourist Review, 54(2), 54-64.

Long, W. C., Swiney, K. M., & Foy, R. J. (2013). Effects of ocean acidification on the embryos and larvae of red king crab, Paralithodes camtschaticus. Marine Pollution Bulletin, 69(1–2), 38-47. doi:http://dx.doi.org/10.1016/j.marpolbul.2013.01.011

Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. Global Environmental Change, 17(3-4), 445-459. doi:10.1016/j.gloenvcha.2007.01.004

Lubell, M., Vedlitz, A., Zaharan, S., & Alston, L. T. (2006). Collective action, environmental activism, and air quality policy. Political Research Quarterly, 59(1), 149-160.

Maibach, E. W., Leiserowitz, A., Roser-Renouf, C., Mertz, C.K., & Akerlof, K. (2011a). Global warming's six Americas screening tools: Survey instruments; instructions for coding and data treatment; and statistical program scripts. Retrieved from George Mason University Center for Climate Change Communication website: http://www.climatechangecommunication.org/global-warmings-six-americas-screening-tools

Maibach, E. W., Leiserowitz, A., Roser-Renouf, C., & Mertz, C. K. (2011b). Identifying like-minded audiences for global warming public engagement campaigns: An audience segmentation analysis and tool development. PLoS One, 6(3), e17571. doi:10.1371/journal.pone.0017571

Markon, C. J., Trainor, S. F., & Chapin, F. S., III. (2012). The United States national climate assessment—Alaska technical regional report (U.S. Geological Survey Circular 1379). Retrieved from U. S. Geological Survey website: http://pubs.usgs.gov/circ/1379/

Masson-Delmotte, V., Schulz, M., Abe-Ouchi, A., Beer, J., Ganopolski, A., González Rouco, J.F., . . . Timmermann, A. (2013). Information from Paleoclimate Archives. In T. F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex & P. M. Midgley (Eds.), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Mathis, J. T., Cross, J. N., & Bates, N. R. (2011). The role of ocean acidification in systemic carbonate mineral suppression in the Bering Sea. Geophysical Research Letters, 31(L19602). doi:10.1029/2011GL048884

McAfee, S. A., Walsh, J., & Rupp, T. S. (2013). Statistically downscaled projections of snow/rain partitioning for Alaska. Hydrological Processes, 28(12), 3930-3946. doi:10.1002/hyp.9934

McDowell Group. (2012). Alaska visitor statistics program VI interim visitor volume report summer 2012. Retrieved from State of Alaska website: http://commerce.alaska.gov/dnn/Portals/6/pub/TourismResearch/AVSP/AVSP_VI_2012_Summer.pdf

McDowell Group. (2014). Economic impact of Alaska's visitor industry 2012-2013 update. Retrieved from State of Alaska website: http://commerce.alaska.gov/dnn/Portals/6/pub/TourismResearch/AVSP/Visitor%20Industry%20Impacts%202013%201_30.pdf

Moser, S. C. (2010). Communicating climate change: history, challenges, process and future directions. WIREs Climate Change, 1(January/February 2010), 31-53. doi:10.1002/wcc.011

Moser, S. C. (2012). Navigating the political and emotional terrain of adaptation: Community engagement when climate change comes home. In S. C. Moser & M. T. Boykoff (Eds.), Successful Adaptation to Climate Change: Linking Science and Policy in a rapidly Changing World. London: Routledge.

Moser, S. C., & Ekstrom, J. A. (2010). A framework to diagnose barriers to climate change adaptation. Proceedings of the National Academy of Sciences of the United States of America, 107(51), 22026-22031. doi:10.1073/pnas.1007887107

Moser, S. C., & Ekstrom, J. A. (2012). Identifying and overcoming barriers to climate change adaptation in San Francisco Bay: Results from case studies. Retrieved from California Energy Commission website: http://www.energy.ca.gov/2012publications/CEC-500-2012-034/CEC-500-2012-034.pdf

Moser, S.C. (2014). Communicating adaptation to climate change: the art and science of public engagement when climate change comes home. Wiley Interdisciplinary Reviews: Climate Change, 5(3), 337–358. doi:10.1002/wcc.276

Moss, R. H. , Meehl, G. A. , Lemos, M. C. , Smith, J. B. , Arnold, J. R. , Arnott, J. C. , . . . Wilbanks, T. J. . (2013). Hell and high water: Practice-relevant adaptation science. Science, 342, 696-698.

Myers, T. A., Maibach, E. W., Roser-Renouf, C., Akerlof, K., & Leiserowitz, A. A. (2013). The relationship between personal experience and belief in the reality of global warming. Nature Climate Change, 3, 343-347. doi:10.1038/nclimate1754

National Research Council. (2010). Adapting to the impacts of climate change. Washington, DC: The National Academies Press.

Neal, E. G., Hood, E., & Smikrud, K. (2010). Contribution of glacier runoff to freshwater discharge into the Gulf of Alaska. *Geophysical Research Letters*, 37(6), n/a-n/a. doi:10.1029/2010gl042385

Nisbet, M. C. (2010). Framing science a new paradigm in public engagement. In L. Kahlor & P. A. Stout (Eds.), *Communicating science new agendas in communication* (pp. 40-67). New York: Routledge.

Nisbet, M. C., & Scheufele, D. A. (2009). What's next for science communication? Promising directions and lingering distractions. *American Journal of Botany*, 96(10), 1767-1778. doi:10.3732/ajb.0900041

O'Connor, R. E., Bord, R. J., & Fisher, A. (1998). The curious impact of knowledge about climate change on risk perceptions and willingness to sacrifice. *Risk Decision and Policy*, 3(2), 145-155.

O'Connor, R. E., Bord, R. J., & Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. *Risk Analysis*, 19(3), 461-471.

O'Neill, S. J., & Hulme, M. (2009). An iconic approach for representing climate change. *Global Environmental Change*, 19(4), 402-410. doi: 10.1016/j.gloenvcha.2009.07.004

Orr, J. C., Fabry, V. J., Aumont, O., Bopp, L., Doney, S. C., Feely, R. A., . . . Yool, A. (2005). Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature*, 437(7059), 681-686. doi:10.1038/nature04095

Pelletier, L. G., & Sharp, E. (2008). Persuasive communication and proenvironmental behaviours: How message tailoring and message framing can improve the integration of behaviours through self-determined motivation. *Canadian Psychology*, 49(3), 210-217. doi:10.1037/a0012755

Peters, G. J., Ruiter, R. A., & Kok, G. (2013). Threatening communication: A critical re-analysis and a revised meta-analytic test of fear appeal theory. Health Psychology Review, 7(Suppl 1), S8-S31. doi:10.1080/17437199.2012.703527

Petty, R. E., & Brinol, P. (2012). The elaboration likelihood model. In P. A. M. Van Lange, A. Kruglanski & E. T. Higgins (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 224-245). London, England: Sage.

Pidgeon, N., & Fischhoff, B. (2011). The role of social and decision sciences in communicating uncertain climate risks. *Nature Climate Change*, 1(April 2011), 35-41. doi:10.1038/nclimate1080

Radić, V., Bliss, A., Beedlow, A. C., Hock, R., Miles, E., & Cogley, J. G. (2013). Regional and global projections of twenty-first century glacier mass changes in response to climate scenarios from global climate models. *Climate Dynamics*, 42(1-2), 37-58. doi:10.1007/s00382-013-1719-7

Renner, M., Arimitsu, M. L., & Piatt, J. F. (2012). Structure of marine predator and prey communities along environmental gradients in a glaciated fjord. *Canadian Journal of Fisheries and Aquatic Sciences*, 69(12), 2029-2045. doi:10.1139/f2012-117

Reser, J. P., & Swim, J. K. (2011). Adapting to and coping with the threat and impacts of climate change. *The American Psychologist*, 66(4), 277-289. doi:10.1037/a0023412

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. Cacioppo & R. Petty (Eds.), *Social Psychophysiology*. New York: Guilford Press.

Romanovsky, V. E., Smith, S. L., & Christiansen, H. H. (2010). Permafrost thermal state in the polar Northern Hemisphere during the International Polar Year 2007-2009: A synthesis. *Permafrost and Periglacial Processes*, 21(2), 106-116. doi:10.1002/ppp.689

Roser-Renouf, C., Stenhouse, N., Rolfe-Redding, J., Maibach, E., & Leiserowitz, A. (in press). Engaging diverse audiences with climate change: Message strategies for global warming's six America's. In A. Hanson & R. Cox (Eds.), *Handbook of Environment and Communication*. London: Routledge.

Safford, T. G., Henly, M., & Ulrich, J. D. (2013). *Jobs, natural resources, and community resilience: A survey of Southeast Alaskans about social and environmental change.* Retrieved from University of New Hampshire Carsey Institute website: http://carseyinstitute.unh.edu/publication/jobs-natural-resources-and-community-resilience-survey-southeast-alaskans-about-social-a

Scannell, L., & Gifford, R. (2011). Personally relevant climate change: The role of place attachment and local versus global message framing in engagement. *Environment and Behavior*, 45(1), 60-85. doi:10.1177/0013916511421196

Schroth, A. W., Crusius, J., Chever, F., Bostick, B.C. , & Rouxel, O.J. (2011). Glacial influence on the geochemistry of riverine iron fluxes to the Gulf of Alaska and effects of deglaciation. *Geophysical Research Letters*, 38(16). doi:10.1029/2011GL048367

Schweizer, S., Davis, S., & Thompson, J. L. (2013). Changing the conversation about climate change: A theoretical framework for place-based climate change engagement. *Environmental Communication: A Journal of Nature and Culture*, 7(1), 42-62. doi:10.1080/17524032.2012.753634

Scott, D., Jones, B., & Konopek, J. (2007). Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park. *Tourism Management*, 28(2), 570-579. doi:10.1016/j.tourman.2006.04.020

Scott, D., & McBoyle, G. (2006). Climate change adaptation in the ski industry. *Mitigation and Adaptation Strategies for Global Change*, 12(8), 1411-1431. doi:10.1007/s11027-006-9071-4

Serreze, M.C., & Barry, R.G. (2011). Processes and impacts of Arctic amplification: A research synthesis. *Global and Planetary Change*, 77(1-2), 85-96. doi:10.1016/j.gloplacha.2011.03.004

Shulski, M., & Wendler, G. (2007). *The climate of Alaska.* Fairbanks, AK: University of Alaska Press.

Simpson, M. C., Gossling, S., Scott, D., Hall, C. M. , & Gladin, E. (2008). *Climate change adaptation and mitigation in the tourism sector: Frameworks, tools, and practices.* Retrieved from the United Nations Environment Programme website: http://www.unep.fr/shared/publications/pdf/DTIx1047xPA-ClimateChange.pdf

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24(2), 311-322.

Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282-292. doi:10.1016/j.gloenvcha.2006.03.008

Stabeno, P. J., Bond, N. A., Hermann, A. J., Kachel, N. B., Mordy, C. W., & Overland, J. E. (2004). Meteorology and oceanography of the Northern Gulf of Alaska. *Continental Shelf Research*, 24(7-8), 859-897. doi:10.1016/j.csr.2004.02.007

Steinacher, M., Joos, F., Frolicher, T. L., Plattner, G. K., & Doney, S. C. (2009). Imminent ocean acidification in the Arctic projected with the NCAR global coupled carbon cycle-climate model. *Biogeosciences*, 6, 515-533.

Stewart, B. C., Kunkel, K. E., Stevens, L. E., Sun, L., & Walsh, J. E. (2013). Regional climate trends and scenarios for the U.S. National Climate Assessment Part 7 Climate of Alaska (NOAA Technical Report NESDIS 142-7). Retrieved from NOAA website: http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-7-Climate_of_Alaska.pdf

Stroeve, J. C., Serreze, M. C., Holland, M. M., Kay, J. E., Malanik, J., & Barrett, A. P. (2011). The Arctic's rapidly shrinking sea ice cover: a research synthesis. *Climatic Change*, 110(3-4), 1005-1027. doi:10.1007/s10584-011-0101-1

Tervo-Kankare, K. (2011). The consideration of climate change at the tourism destination level in Finland: Coordinated collaboration or talk about weather? *Tourism Planning & Development*, 8(4), 399-414. doi:10.1080/21568316.2011.598180

Trainor, S. F., Walsh, J., & Yu, G. (2009). Towards predicting the impact of climate change on tourism: An hourly tourism climate index. *Alaska Park Science*, December 2009, 133-137.

Trawöger, L. (2014). Convinced, ambivalent or annoyed: Tyrolean ski tourism stakeholders and their perceptions of climate change. *Tourism Management*, 40, 338-351. doi:10.1016/j.tourman.2013.07.010

Tversky, A., & Shafir, E. (1992). The disjunction effect in choice under uncertainty. *Psychological Science*, 3, 305-309.

Wang, M., & Overland, J. E. (2012). A sea ice free summer Arctic within 30 years: An update from CMIP5 models. *Geophysical Research Letters*, 39(L18501).

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *The American Psychologist*, 66(4), 315-328. doi:10.1037/a0023253

Weingartner, T. J., Danielson, S. L., & Royer, T. C. (2005). Freshwater variability and predictability in the Alaska Coastal Current. *Deep Sea Research Part II: Topical Studies in Oceanography*, 52(1-2), 169-191. doi:10.1016/j.dsr2.2004.09.030

Whitmarsh, L. (2011). Scepticism and uncertainty about climate change: Dimensions, determinants and change over time. *Global Environmental Change*, 21(2), 690-700. doi:10.1016/j.gloenvcha.2011.01.016

Wolken, J. M., Hollingsworth, T. N., Rupp, T. S., Chapin, F. S., Trainor, S. F., Barrett, T. M., . . . Yarie, J. (2011). Evidence and implications of recent and projected climate change in Alaska's forest ecosystems. *Ecosphere*, 2(11), art124. doi:10.1890/es11-00288.1

Yu, G., Schwartz, Z., & Walsh, J. E. (2009). Effects of climate change on the seasonality of weather for tourism in Alaska. *Arctic*, 62(4), 443-457.

Project Overview

[423231-8] Community and institutional response to climate change in SE Alaska

You have Full access to this project. (Edit)

Research Institution University of Alaska Fairbanks, Fairbanks, AK
Title Community and institutional response to climate change in SE Alaska
Principal Investigator Brinkman, Todd, PhD
Keywords Community, climate change, institutions
Sponsor UAF

The documents for this project can be accessed from the **Designer**.

Project Status as of: 07/22/2014

Reviewing Board	Initial Approval Date	Project Status	Expiration Date
University of Alaska Fairbanks IACUC, Fairbanks, AK			
University of Alaska Fairbanks IBC, Fairbanks, AK			
University of Alaska Fairbanks IRB, Fairbanks, AK	02/28/2013	Active	02/28/2015

Package 423231-8 is: Locked

Package 8 of 8 | Jump |

Submitted To	Submission Date	Submission Type	Board Action	Effective Date	
University of Alaska Fairbanks IRB, Fairbanks, AK	04/11/2014	Continuing Review/Progress Report	Approved	04/17/2014	| Review Details |

Shared with the following users:

User	Organization	Access Type
Brinkman, Todd	University of Alaska Fairbanks, Fairbanks, AK	Full
Powell, Jim	University of Alaska Fairbanks, Fairbanks, AK	Full
Timm, Kristin	University of Alaska Fairbanks, Fairbanks, AK	Full
Wandersee, Sarah	University of Alaska Anchorage, Anchorage, AK	Full

REARCH RELEASE FORM
Community & Organizational Response to Environmental Changes in Southeast Alaska

STUDY PURPOSE: The purpose of this study is to provide communities and scientists with local information about changes in the environment. Information from local residents will be gathered from volunteer residents about their observations and activities related to those changes. This study is consistent with research guidelines of the University of Alaska and research guidelines established in 1993 by the Alaska Federation of Natives.

TIMEFRAME: During the next 2-5 years we intend to develop a report about the information we gather. When possible and only with permission, we would like to video and record individual and group interviews. The records and video will be used to learn about what communities and organizations are experiencing and share that information with other scientists. Copies of a final report, articles, and video about what we learned will be presented and given to the communities and organizations that participate in the study. If you provide email and/or mailing address a copy will be sent to you.

CONSENT: The audio and video will be used for research only if and when the individuals and local tribal council give permission. Only the information that you are willing to release will be gathered or become part of the research record. After the study is completed and a draft report or video is completed it will be presented to the City Council for their review and approval or disapproval for use in education or research.

By signing, I give the University of Alaska Fairbanks (UAF) permission to audio record or video me and to use the video or audio for research purposes, such as academic reports, articles, and educational videos. I agree that the photographs and video are the property of UAF and hereby release UAF from any and all claims that I may have from its use of my image or voice.

Print Name_____

Email _____

Signature _____ **Date** _____

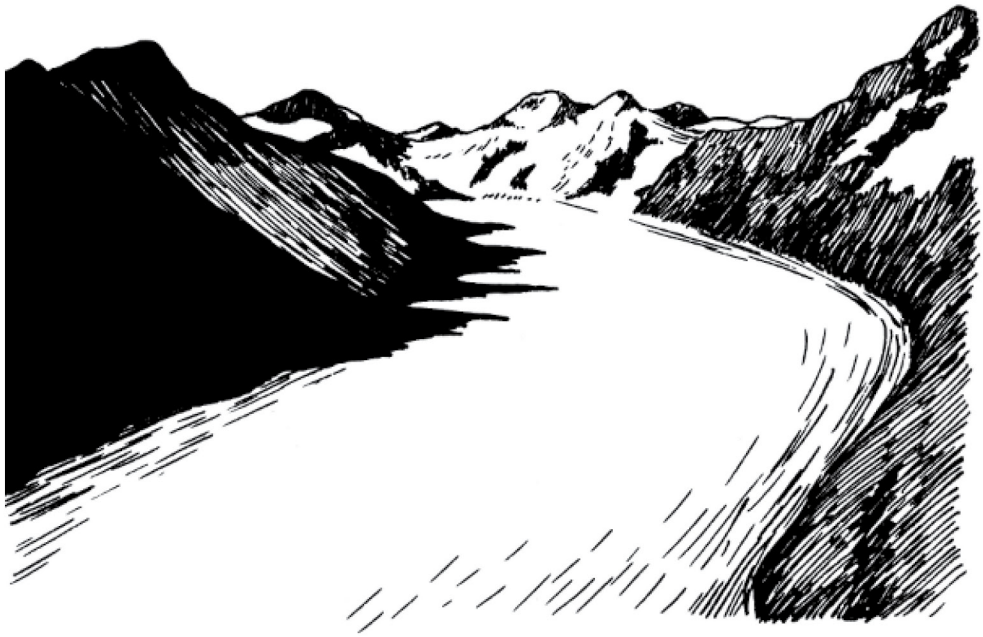
Address _____ **phone** _____

City _____ **State** _____ **zip**_____

Alaska EPSCoR Experimental Program to Stimulate Competitive Research

Note: The following questions were added by a colleague and were not used in the analysis for this study: A7, B5, B6, B7, B10, B11, B12, D1, E1, E2. E3, E7, E8, F1, F2, G16, and G17.

Institutional Response to Environmental Change in Southeast Alaska



UAS UNIVERSITY OF ALASKA SOUTHEAST
learn · engage · change

UAF UNIVERSITY OF ALASKA FAIRBANKS

Alaska EPSCoR

SNAP

AK CSC
Alaska Climate Science Center

NSF Award # OIA-1208927

Jim Powell, PhD
Scenarios Network for Alaska and Arctic Planning, University of Alaska Fairbanks
10601 Horizon Drive
Juneau, Alaska 99801
907.209.5676
jim23powell@gmail.com

Kristin Timm, MSc Candidate
University of Alaska Fairbanks
3352 College Road
Fairbanks, AK 99709
907.474.7064
kmtimm@alaska.edu

Section A: Background information

In this first section, we would like to learn a little more about you and your organization.

1. Age: _____

2. Gender
- a) Male
- b) Female
- c) Prefer not to say

3. What is your position in your organization?
- a) Program Director or Executive
- b) Mid-level Manager
- c) Staff
- d) Other (please explain): _____

4. How long have you worked in your area of expertise?
- a) Less than 5 years
- b) 5-15 years
- c) More than 15 years

5. What is the highest level of education that you have completed
- a) Less than 12th Grade (no diploma)
- b) High school graduate or equivalent
- c) Some college or post high school training
- d) Two year technical or associate degree
- e) Four year college degree (BA/BS)
- f) Graduate or professional degree (MS, JD, MD, Ph.D.)

6. At which scale or area does your organization work?
- a) 1-5 acres
- b) Watershed
- c) Juneau community
- d) Southeast Alaska
- e) Statewide
- f) Beyond Alaska
- g) Other (please explain): _____

7. Does your organization:
- a) Collect data in Berners Bay
- b) Use natural resources in Berners Bay
- c) Manage natural resources in Berners Bay
- d) None of the above

If you selected a, b, or c, please describe: _____
_____
_____

8. How many employees does your organization have?

a. Full time: _____
b. Part time or seasonal: _____

9. How many years has your organization been established? _____

10. Is Alaska your primary state of residency?

a. Yes
b. No
c. Don't know

11. What types of activities does your organization offer (check all that apply)?

☐ Fixed wing flight seeing
☐ Helicopter flight seeing
☐ Icefield or glacier trekking/landing
☐ Tidewater glacier viewing
☐ Dog sled tours
☐ Whale watching
☐ Offshore fishing
☐ Deepwater fishing
☐ Stream/river fishing
☐ Mendenhall Glacier
☐ Land-based sightseeing
☐ Other (please explain): _____
_____
_____

Section B: Organizational Processes and Structures

The following questions are about your organization. We would like to learn about the ways your organization is thinking about and responding to environmental change, including climate change.

1. Do environmental changes, including climate change, impact your organization?

a. Yes [PROCEED TO QUESTION 2]
b. No [PROCEED TO SECTION C]
c. Don't know

Please describe: _____
_____
_____

2. Is your organization responding to climate change in Southeast Alaska?

a. Yes [PROCEED TO QUESTION 4]
b. No [PROCEED TO QUESTION 3]
c. Don't know

3. Why do you think your organization is not responding?

_____
_____
_____
_____

4. What are the ways your organization is responding to climate change (circle all that apply):

a. We are starting to discuss climate change
b. We are gathering information to better understand the issue
c. We have created a task force
d. We have a written strategy, but not yet implemented
e. We have a written strategy and are currently implementing it
f. We have increased the number of staff dedicated to climate change
g. We have a program or project for climate change impacts or adaptation
h. It has become part of our decision-making process
i. Don't know
j. Other (please explain): _____
_____
_____
_____

5. How likely is it that your organization will take actions to reduce the potential impacts of climate change?

a. Very unlikely
b. Unlikely
c. Neutral
d. Likely
e. Very likely
f. Don't know

6. How effective do you think changes to the structure of your organization could be to adapting to the potential climate change impacts?

a. Very ineffective
b. Ineffective
c. Neutral
d. Effective
e. Very effective
f. Don't know

7. How likely is it that your organization will expand monitoring activities for climate changes?

a. Very unlikely
b. Unlikely
c. Neutral
d. Likely
e. Very likely
f. Don't know

8. Could you describe what prompted your organization to respond to climate change (i.e. specific events or situations)?

_____
_____
_____
_____

9. Describe the barriers your organization has faced in responding to climate change:

_____
_____
_____
_____

10. Has your organization participated in meetings with other organizations about climate change?

a. Yes
b. No
c. Don't know

11. How much time is your organization dedicating to climate change?

a. Someone may participate in a few meetings annually
b. An occasional part of one person's job
c. Quarter of one full-time position
d. Half of one full-time position
e. One full-time position
f. More than one full-time position
g. Other (please explain): _____

12. Do you anticipate a need for a climate change program in your organization in the future? If so, please try to characterize the future resources needed for such a program and how it would fit in the organizational structure?

_____
_____
_____
_____

13. Climate projections suggest warmer weather and increased precipitation in Southeast Alaska. This could mean changes in weather patterns. If these projections are correct, how would your organization respond to these changes? Please indicate which apply.

a. Change your business/management practices
b. Increase interactions with similar organizations
c. Don't know
d. Other (please explain): _____
_____
_____

14. Do you foresee any opportunities that may emerge if climate projections of warmer weather and increased precipitation occur? If so, what?

_____
_____
_____
_____

15. Can you imagine any "tipping points" caused by changes to climate change (either good or bad) for your organization, where you would no longer be able to function as you do currently? If so, please describe.

_____
_____
_____
_____

Section C: Information and communication processes

We would like to learn about your the information sources you use for your work and whether you are finding the information you would like about climate change.

1. For your work in general, how often do you use the following information sources?

	Daily	Weekly	Monthly	Quarterly	Annually	Never
Colleagues in my organization	1	2	3	4	5	6
Colleagues in similar organizations	1	2	3	4	5	6
Consultants	1	2	3	4	5	6
Individuals at research or academic institutions	1	2	3	4	5	6
Federal agencies	1	2	3	4	5	6
Internet (world wide web)	1	2	3	4	5	6
Meetings or conferences	1	2	3	4	5	6
Non-governmental organizations	1	2	3	4	5	6
Planning documents	1	2	3	4	5	6
Professional associations	1	2	3	4	5	6
Professional e-mail lists	1	2	3	4	5	6
Professional journals	1	2	3	4	5	6
Scientific journals	1	2	3	4	5	6
State agencies	1	2	3	4	5	6
Weather forecasts	1	2	3	4	5	6

Other (please explain): _____
_____

2. For your work, how often do you use information about climate change?

a. Daily
b. Weekly
c. Monthly
d. Quarterly
e. Annually
f. Never

3. For your work, where do you go for information about climate change?

_____
_____
_____

4. How easy or difficult is it for you to find relevant information about climate change?

_____
_____
_____

5. To what extent do you agree or disagree with the following statements:

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	Don't know
My organization wants to learn more about climate change.	-3	-2	-1	0	1	2	3	X
My organization agrees about the climate change information we need.	-3	-2	-1	0	1	2	3	X
Climate change information is easy for my organization to find.	-3	-2	-1	0	1	2	3	X
Climate change information is easy for my organization to understand.	-3	-2	-1	0	1	2	3	X
Climate change information has too much scientific detail.	-3	-2	-1	0	1	2	3	X
Climate change information lacks scientific detail.	-3	-2	-1	0	1	2	3	X
My organization has been able to answer the questions we have about climate change.	-3	-2	-1	0	1	2	3	X
My organization has been able to find concrete examples of the way climate change may affect us.	-3	-2	-1	0	1	2	3	X
My organization finds the sources of climate change information to be credible.	-3	-2	-1	0	1	2	3	X
The process used to generate climate change information is legitimate.	-3	-2	-1	0	1	2	3	X
My organization is willing to use climate change information.	-3	-2	-1	0	1	2	3	X

6. For your organization, how useful is information that addresses climate change impacts:

	Very useful	Moderately useful	Slightly useful	Not useful	Don't know
a. Occurring this season	1	2	3	4	x
b. Likely to occur in 1-5 years	1	2	3	4	x
c. Likely to occur in 5-25 years	1	2	3	4	x
d. Likely to occur in 25-50 years	1	2	3	4	x
e. Likely to occur in 50 years or more	1	2	3	4	x

7. For your organization, how useful is information about climate change impacts in:

	Very useful	Moderately useful	Slightly useful	Not useful	Don't know
The Berners Bay area	1	2	3	4	x
Within 50 miles of Juneau	1	2	3	4	x
All of Southeast Alaska	1	2	3	4	x
All of Alaska	1	2	3	4	x
All of the United States	1	2	3	4	x

8. Could you describe the characteristics of the information (i.e. length, delivery, format, etc.) that makes climate change information useful to your organization?

_____
_____
_____
_____

9. Does your organization work with scientists or research organizations on any projects?

a. Yes
b. No
c. Don't know

10. If yes on 9, describe the nature of the project and relationship that you have with scientists or research organizations.

_____
_____
_____
_____

11. Has your organization ever been asked about the kind of information you would like about climate change in Southeast Alaska? By whom?

_____
_____
_____
_____

Section D: Usefulness of Climate Change Science

1. Please indicate the extent to which you agree or disagree with the statements below.

	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree	Don't know
a. Using climate change science is within my job description and responsibilities.	-3	-2	-1	0	1	2	3	x
b. Other people in my organization are currently using climate change science.	-3	-2	-1	0	1	2	3	x
c. Climate change science is useful in long-term land use planning.	-3	-2	-1	0	1	2	3	x
d. Climate change science is useful for specific management projects.	-3	-2	-1	0	1	2	3	x

Section E: Climate change impacts on Ecosystem Services

Ecosystem services is a term for the benefits that humans receive from natural resources. We're particularly interested in how ecosystem services could change as a result of climate induced changes to glaciers, streams (runoff), and estuaries (mixing zones of freshwater and saltwater).

1. How useful is the concept of ecosystems services useful to your organization?

a. Very useful
b. Moderately useful
c. Slightly useful
d. Not useful
e. Don't know

2. How appropriate do you think it is to put a dollar value on the benefits that society derives from ecosystem services?

a. Inappropriate
b. Slightly inappropriate
c. Neutral
d. Slightly appropriate
e. Appropriate
f. Don't know

3. How important are the following systems to your organization?

	Not at all important	Not too important	Somewhat important	Very important	Highly important	Don't know
Glaciers	1	2	3	4	5	x
Streams	1	2	3	4	5	x
Estuaries	1	2	3	4	5	x

4. Are there other natural systems that are particularly important to your organization?

_____
_____
_____

5. In the past, have you ever had to shift your business model to respond to changes in glaciers, streams, or estuaries? If yes, please describe.

_____
_____
_____
_____

6. At what point would changes in glaciers impact your business?

_____
_____
_____
_____

7. How important are the following systems to the socio-economic well being of Juneau?

	Not at all important	Not too important	Somewhat important	Very important	Highly important	Don't know
Glaciers	1	2	3	4	5	x
Streams	1	2	3	4	5	x
Estuaries	1	2	3	4	5	x

8. To what degree do glaciers influence estuaries?

a. No influence
b. Minor influence
c. Moderate influence
d. Major influence
e. Don't know

Section F: Vulnerability and adaptation to climate change impacts

1. For each item please indicate how LIKELY you think the climate change impact is in Southeast Alaska.

	How LIKELY is this climate change impact?					
	Very unlikely	Unlikely	Neutral	Likely	Very likely	Don't know
a. Increase in mean annual temperatures	-2	-1	0	1	2	X
b. Increase in dew point	-2	-1	0	1	2	X
c. Less snow in winter months	-2	-1	0	1	2	X
d. Increase in stream temperatures	-2	-1	0	1	2	X
e. Changes in the snowpack	-2	-1	0	1	2	X
f. Changes in the timing of salmon migration	-2	-1	0	1	2	X
g. Changes in the relative sea level	-2	-1	0	1	2	X

2. For each item please indicate how SEVERE you think the climate change impact will be in Southeast Alaska.

	How SEVERE will the impact to Southeast Alaska be?					
	No impact	Some impact	Mod impact	Severe Impact	Very severe impact	Don't know
a. Increase in mean annual temperatures	0	1	2	3	4	X
b. Increase in dew point	0	1	2	3	4	X
c. Less snow in winter months	0	1	2	3	4	X
d. Increase in stream temperatures	0	1	2	3	4	X
e. Changes in the snowpack	0	1	2	3	4	X
f. Changes in the timing of salmon migration	0	1	2	3	4	X
g. Changes in the relative sea level	0	1	2	3	4	X

Section G: Attitudes about climate change

We would like to know more about your personal attitudes about climate change. These questions come from a nationally administered survey about climate change attitudes and beliefs.

1. Do you think that climate change is happening?

Yes...

a. ...and I'm extremely sure
b. ...and I'm very sure
c. ...and I'm somewhat sure
d. ...but I'm not at all sure

No...

e. ...and I'm extremely sure
f. ...and I'm very sure
g. ...and I'm somewhat sure
h. ...but I'm not at all sure

Or...

i. I don't know

2. Assuming climate change is happening, do you think it is ...

a. Caused mostly by human activities
b. Caused mostly by natural changes in the environment
c. Other
d. None of the above because global warming isn't happening

3. How worried are you about climate change?

a. Very worried
b. Somewhat worried
c. Not very worried
d. Not at all worried

4. How much do you think climate change will harm you personally?

a. Not at all
b. Only a little
c. A moderate amount
d. A great deal
e. Don't know

5. When do you think climate change will start to harm people in the United States?

a. They are being harmed now
b. In 10 years
c. In 25 years
d. In 50 years
e. In 100 years
f. Never

6. How much do you think climate change will harm future generations of people?

a. Not at all
b. Only a little
c. A moderate amount
d. A great deal
e. Don't know

7. How much had you thought about climate change before today?

a. A lot
b. Some
c. A little
d. Not at all

8. How important is the issue of climate change to you personally?

a. Not at all important
b. Not too important
c. Somewhat important
d. Very important
e. Extremely important

9. How much do you agree or disagree with the following statement: "I could easily change my mind about climate change."

a. Strongly agree
b. Somewhat agree
c. Somewhat disagree
d. Strongly disagree

10. How many of your friends share your views on climate change?

a. None
b. A few
c. Some
d. Most
e. All

11. Which of the following statements comes closest to your view?

a. Climate change isn't happening.
b. Humans can't reduce climate change, even if it is happening.
c. Humans could reduce climate change, but people aren't willing to change their behavior so we're not going to.
d. Humans could reduce climate change, but it's unclear at this point whether we will do what's needed.
e. Humans can reduce climate change, and we are going to do so successfully.

12. Do you think citizens themselves should be doing more or less to address climate change?

a. Much less
b. Less
c. Currently doing the right amount
d. More
e. Much more

13. Over the past 12 months, how many times have you punished companies that are opposing steps to reduce climate change by NOT buying their products?

a. Never
b. Once
c. A few times (2-3)
d. Several times (4-5)
e. Many times (6+)
f. Don't know

14. Do you think climate change should be a low, medium, high, or very high priority for the President and Congress?

a. Low
b. Medium
c. High
d. Very high

15. People disagree whether the United States should reduce greenhouse gas emissions on its own, or make reductions only if other countries do too. Which of the following statements comes closest to your own point of view? The United States should reduce its greenhouse gas emissions ...

a. Regardless of what other countries do
b. Only if other industrialized countries (such as England, Germany and Japan) reduce their emissions
c. Only if other industrialized countries and developing countries (such as China, India and Brazil) reduce their emissions
d. The US should not reduce its emissions
e. Don't know

16. Which term most accurately describes your political orientation:

a. Very Liberal
b. Liberal
c. Slightly Liberal
d. Neutral
e. Slightly Conservative
f. Conservative
g. Very Conservative

17. What is the first thought or image that comes to your mind when you think of climate change?

_____
_____

18. Is there one major question about climate change in Southeast Alaska that you would really like to know the answer to?

_____
_____
_____
_____

Nature-Based Tourism Operator Response to Environmental Change in Juneau, Alaska

Coding Guide - ENVIRONMENT

Environmental themes also coded for observatons, present risks, and future risks.

Weather	
Fog	Participant shares observations or concerns about fog and impacts to visibility.
Rain	Participant shares observations or concerns about precipitation that falls as rain, quantities or qualities of rain or rain events.
Snow	Participant shares observations or concerns about precipitation that falls as snow, quantities or qualities of snow or snow events.
Summer season	Participant shares information about the summer season generally, such as length, traits, attitudes, experiences, etc.
Temperature	Participant shares observations or concerns about the ambient air temperatures.
Wind	Participant shares observations or concerns related to wind.
Winter season	Participant shares information about the winter season generally, such as length, traits, attitudes, experiences, etc.

Glaciers	
Access	Participant describes changes to glaciers that influence access, whether by vehicle, foot, boat, air, or other methods.
Advancing	Participant describes growth or advance of glacier.
Receding	Participant describes recession, shrinking, or thinning of glacier, including changes in terminus location, or makes general comment about the disappearance of glaciers.
Runoff	Participant describes observations or concerns related to glacier runoff, including amounts, timing, or flooding events.
Safety	Participant describes changes to glaciers that influence travel safety, such as crevasses, icefalls, or other safety problems.
Snow	Participant shares observations related to snow or snowcover on glaciers, including the amount, rate of melt, location of ablation zone, or transient snowline, etc.
Tidewater	Participant describes a tidewater glacier, or phenomena related to tidewater glaciers, such as calving or icebergs.

Fish and Wildlife	
Fish	Participant makes a general comment about fish, multiple species, or act of fishing.

Institutional	Participant makes a comment that generally pertains to social structures and rules.
Perceptions	
Observed	Participant describes environmental characteristics or changes they have encountered or observed.
Future Risk	Participant talks about environmental changes that could be a risk to their operations at some point in the future (near and far future).
Indifferent	Participant talks about changes that have happened or may happen, but that it didn't/doesn't affect them or their operations.
Opportunity	Participant talks about changes that have happened or may happen, and that has or may create an opportunity for them.
Present Risk	Participant describes environmental characteristics or changes they have encountered or observed, that posed some type of a risk that they may or may not have overcome.
Hesitant to Connect	Participant talks about environmental changes, but is hesitant to connect them with "global warming" or "climate change".

Coding Guide - Organization Response

Organization Response	
Type of Response Code	**Definitions**
No response	Participant describes that no response was taken nor is planned. No adaptation goals or efforts.
Unplanned Adaptation	Participant describes an immediate coping measure or an automatic response to a change in a natural or social system. Low effort, limited planning, short range goals.
Planned Adaptation	Participant describes undertaking a deliberate adaptation process that has an identifyable beginning and end, a decision to act and includes an awareness that the conditions have or will change and that action is required to attempt to maintain a given state. High effort, long range goals.
No Response Sub-Codes	
No Signal	Participant denies or does not detect a signal that would elicit an adaptation response.
Uncertain	Participant describes feeling uncertain of what will happen, so not responding.
Fatalistic	Participant describes feeling unable to control the situation or being powerless to do anything other than what they do.
Optimistic	Participant describes that they will be able to adapt and that they will just respond, no matter what happens. Confident that they will be able to adapt to whatever happens.
Thresholds	Participant describes a point where, if passed, they would have to adapt or would no longer be able to operate the way that they currently do. May be just environmental or combination of factors.
Unplanned Adaptation Sub-Codes	
Coping Measures	Participant describes a specific short-term reaction or response to a given environmental (or socio-environmental) stimulus.
Used to Variability	Participant describes operating under a great deal of variability and they are able to handle issues related to climate change impacts.
System in Place	Participant describes that the current way they operate can handle the issues related to climate change impacts.
Opportunities	Participant describes taking advantage or or looking for new opportunities, to potentially replae those that may no longer exist.
Research / Observe	Participant describes working with researchers, making their own formal or informal observations of the enviornment.

Discussions and Meetings	Participant describes having conversations, meetings, etc. about climate change.
Diversify	Participant describes new business ventures or ways they will diversify when its needed.
Other Response Codes	
Used Interchangably	Participant describes the mitigation, conservation, adaptation, and/or environmental stewardship activitied interchagibly.
Other Adaptation / Response	Other comments related to adaptation or response.
Barriers	
No Barriers	Participant does not identify any barriers to responding.
Money / Resources	Participant describes being limited by money or resources, such as personnel resources.
Institutional	Participant describes local rules (formal or informal) that inhibit a response.
Information	Participant describes not being able to find the information they need or the information is flawed.
Communication	Participant describes how the communication process, or lack of, presents barriers.
Other Barriers	Other barriers not already identified.

Nature-Based Tourism Operator Response to Environmental Change in Juneau, Alaska

Coding Guide - Information & Communication

Information and Communication Codes	
Information	**Definitions (Participant describes...)**
Sources	the places they tend to go for information.
Ease of Access	
Easy	that its easy to find information about climate change.
Challenging	that its challening to find information about climate change.
Frequency of Use (Climate Change Information)	
Daily	using climate change (or weather) information daily.
Monthly/Seasonally	using climate change (or weather) information monthly or seasonally.
Annually	using climate change (or weather) information annually.
Never	never using climate change information.
Characteristics	
Characteristics	the types of qualities of the information that make it useful.
Engagement	
Never	never interacting with scientists or research organizations.
Transportation	interacting with scientists or research orgs to provide transportation.
Interact	interacting with scientists or research orgs in general, beyond transportation.
Observations	interacting with scientists or research orgs to help with observations of environmental conditions.
Part of Operations	interacting with scientists or research orgs as part of their tour operations (i.e. citizen science tours).
Negative View of Scie	have a negative view of scientists an/ or research orgs.
Subjects of Interest	
Salmon/Oceans/Fish	having questions about how climate change influences salmon, oceans, fish, etc.
Cryosphere	having questions about how climate change influences snow, ice, glaciers, etc.
Weather / Climate	having questions about how climate change influences weather, temp, precip, etc.

General Uncertainty	having questions about how climate change in general or general uncertainty.
Visitor Information	
Visitor Information	describes needing information for their visitors, or describes how often visitors ask about climate change or how they respond.